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AVIATION

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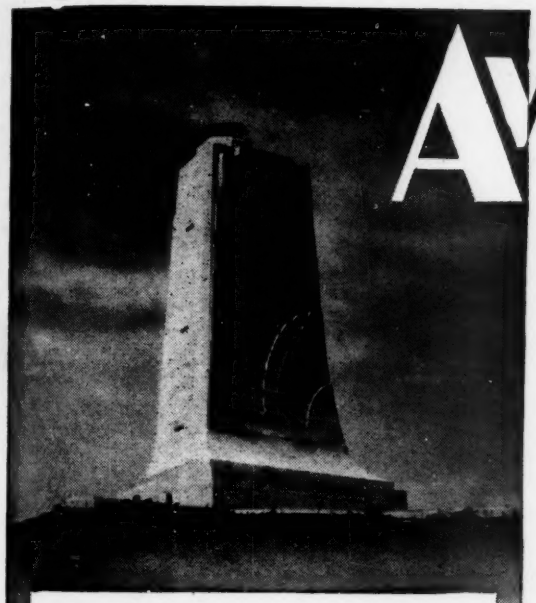

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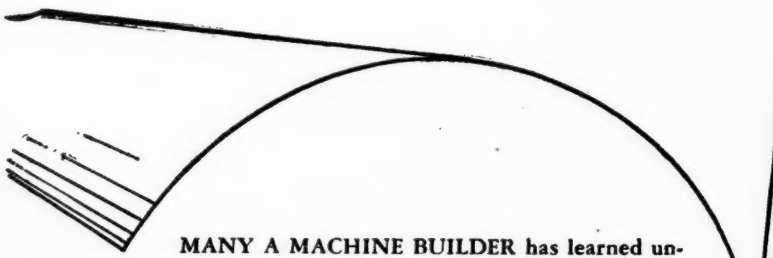
A LESSON FOR NEW PRODUCTS



MANY A MACHINE BUILDER has learned under wartime pressure the amount of machining that Laminum shims save . . . and new peacetime products will benefit! (1) Quicker fitting of bearings, gear mesh, etc. (2) Certainty of uniform accuracy because of the precision gauge of the laminations. Want performance data?

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from which flap has been lifted. Replace flap on tube, stitch all of repair, and cure 20 min.

Bead Repairs

Torn fabric between bead wire and inside edge of bead.

When tear is partially through bead:

1. Buff area with carborundum stick and cement.
2. Fill tear with gum, stitch and cure 10 min.

When tear is entirely through bead:

1. Buff area with carborundum stick and cement.
2. Fill hole or tear with gum and stitch.
3. Cut two patches of lightweight reinforcing fabric to extend ¼ in. on all sides of tear.
4. Wash and cement patches and position on front and back of bead. Stitch down and cure 20 min.

If fabric on or over bead wire area is torn:

1. Buff area around tear allowing ¼ in. clearance on face and back and cement.
2. Pack tear flush with gum.
3. Wash and cement one patch of light reinforcing fabric that will cover buffed area and wrap it around bead wire.
4. Fit patch to prepared area and stitch thoroughly, then cure 20 min.

Broken bead wire:

1. Cut through buffer strip at point opposite broken wire and lay strip back 3 in. each side of break.
2. With sharp pointed scissors or knife, split top layer of bead fabric in center of channel covered by buffer strip.
3. With knife, separate top ply from lower ply of bead fabric until bead wire is exposed.
4. Straighten ends and buff wire until broken ends of wire can be snugly inserted into metal bead clip. Place brazed side of clip down.
5. Place flat piece of metal underclip, then dent clip with small prick punch two places at each end but not in center where broken ends meet.
6. Wash bead fabric which has been separated and cement.
7. Place a strip of .010 gum covering surface of lower exposed bead fabric.
8. Stitch upper bead fabric into place.
9. Cement buffer strip and channel.
10. Lay strip of ⅛ in. .010 gum over and cure 15 min.
11. Stitch raised buffer strip into place cut in fabric.

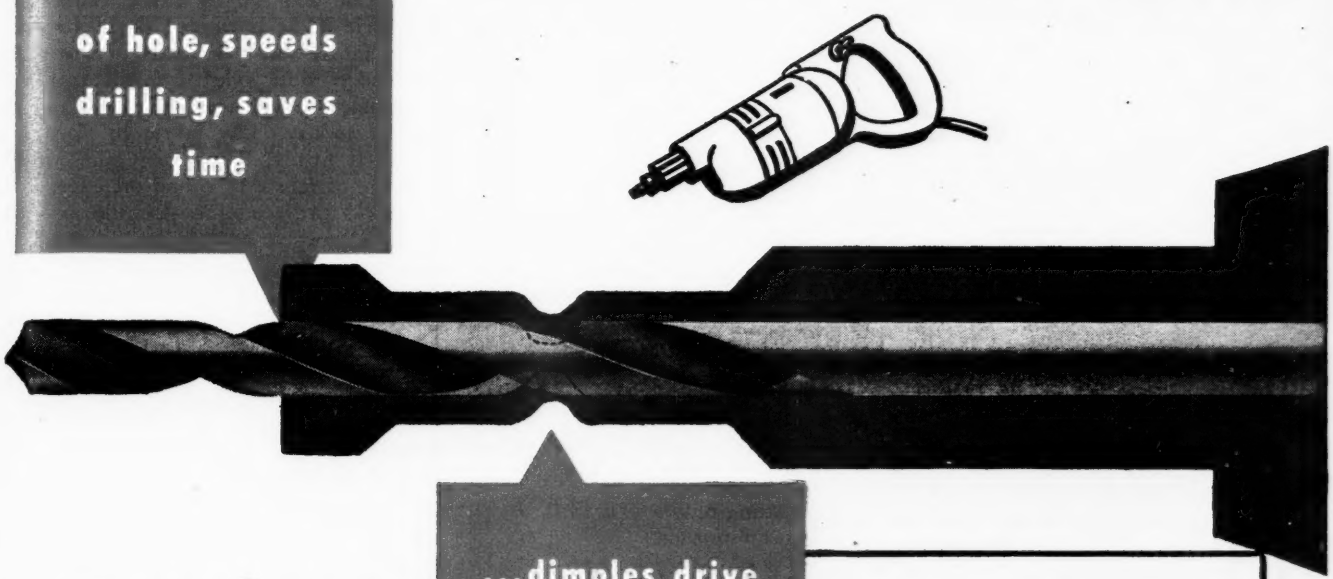
To slip fabric on bead wire:

1. Fasten end of bead wire in vise.
2. Tape jaws of common slip-joint pliers and place over bead near vise so bead wire will be in open space behind clamping surface of jaws.
3. Using both hands, clamp jaws on fabric just under the wire and jerk back. This will loosen fabric and cause

New Protector & Depth Gauge

Ends Drill Breakage!

...gauges depth of hole, speeds drilling, saves time



...dimples drive drill close to point where work is being done

NOW YOU CAN drill faster—*and not worry about breakage!* The new Hartwell split-shank drill protector & depth gauge protects your drill at the weakest point. And it lets you set your drill for any desired depth.

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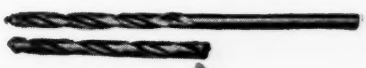
3. Split shank. The shank of the protector & depth gauge is split to permit the chuck to lock the drill at any desired depth setting.



4. Straight shank or broken drills. Either straight shank or broken drills, without shanks, can be used in the protector & depth gauge.

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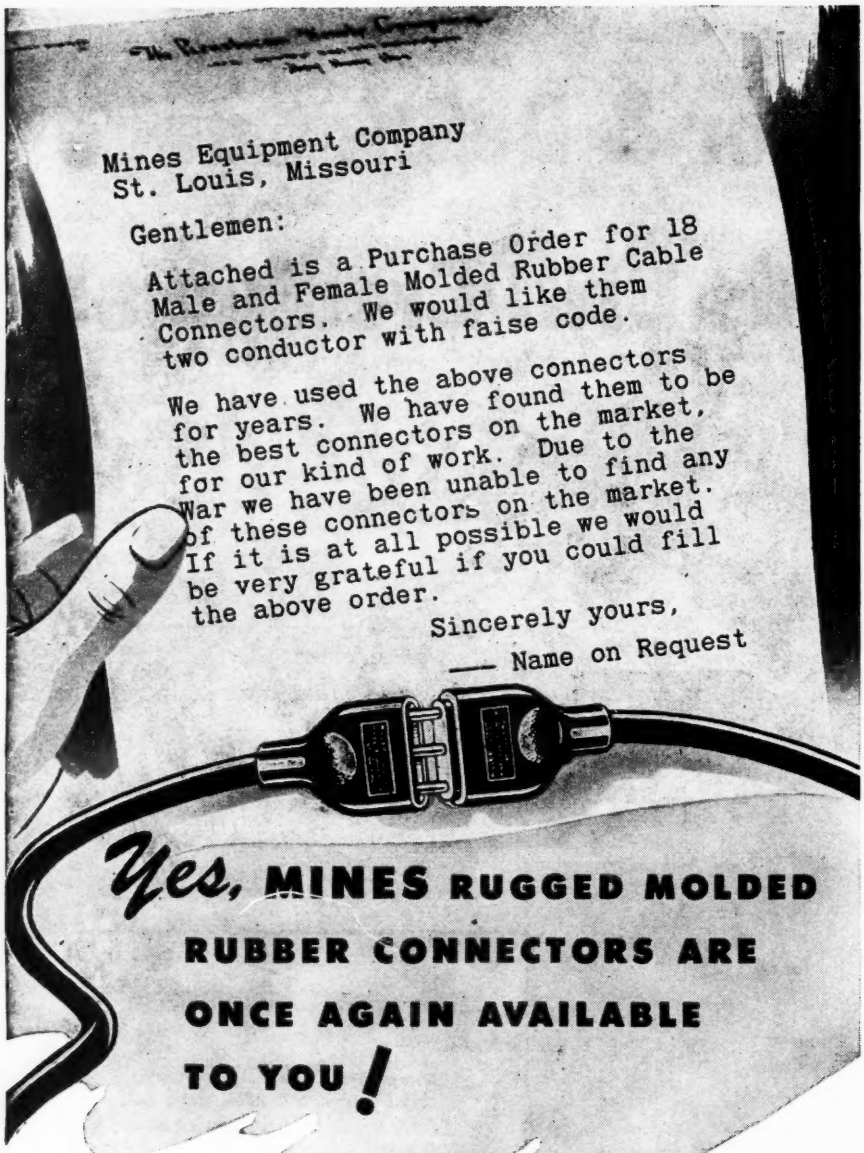
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Attached is a Purchase Order for 18 Male and Female Molded Rubber Cable Connectors. We would like them two conductor with faise code.
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it to wrinkle on wire ahead of plier jaws.

4. Place plier jaws over wrinkles formed in bead fabric and jerk again. Continue this procedure until fabric is loose from wire.

End-Reinforcement Repairs

Repairing a hole or tear:

1. Rout gum off back of de-icer to coated reinforcing fabric. Allow ½ in. clearance around damage. Cement and allow to dry, then cover routed area with .010 gum.

2. Cut a piece of cured reinforcing fabric to fit in routed area. (Stretch in fabric must be at right angles to bead.) Buff side of fabric that will contact routed area. Cement and allow to dry. Lay fabric in place and stitch firmly, then place gum around edge of fabric to round off edge.

3a. With face of de-icer up, proceed as follows *if tear is small:* Rout V-trough along tear or bevel edges of hole. Buff ⅛ in. beyond, then cement trough or beveled edges and fill flush with gum.

3b. *If large hole:* Cut a piece of stretch area from scrap de-icer to fit hole. Rout V-trough along butted edges. Buff ⅛ in. beyond, then cement trough and fill with gum.

4. Cure 10 min., each side, and restore conductive surface.

If tear is along bead:

1. Loosen buffer strip 2 in. beyond tear and rout coated reinforcing fabric from bead notch, ½ in. beyond end of tear.

2. Rout rubber down to fabric on other side of tear, allowing ½ in. clearance, then wash and cement.

3. Cover routed areas with .010 gum and cement.

4. Cut a piece of cured coated reinforcing fabric to fit, then buff and cement side of fabric to be applied.

5. Fill in with gum around fabric to round off edges.

6. On face side, rout a V-trough in tear. Buff ⅛ in. beyond, wash and cement, then pack flush to de-icer surface with gum.

7. Cure 10 min. on each side and restore conductive surface.

Snubber Repairs

Tears in fabric:

1. Wash and buff an area ½ in. wide on all sides of tear and cement.

2. Wash and cement a piece of uncured reinforcing fabric that will cover buffed area. In this case, fabric stretch must be in same direction as bead.

3. Position fabric and stitch firmly in position.

4. Cement edges of tear on opposite side and fill tear flush with gum, then cure 15 min.

Repairing broken de-icer bead wire:

1. Separate snubber fabric at edges of lap. Cut back until snubber wire is exposed, then remove broken wire.
2. Wash exposed wire bed and separated surfaces of snubber fabric and roughen thoroughly surface of areas.
3. Cement new snubber wire and fabric areas which contact wire, with 50-50 mixture of air-cure cements.
4. Cement separated surfaces of lap, lay new wire into position, re-lay fabric, and stitch thoroughly.
5. Cure entire length by spot curing. Allow 5 min. for each spot cure.

Boeing Stratocruiser

(*Continued from page* 177)

controls permits any two of the Stratocruiser's engines to be run up to full throttle with surfaces locked, thus permitting safe taxiing and engine run-ups in high winds. Takeoff with surfaces locked is impossible. Nor can the surfaces be locked in flight. The elevator controls are duplicated in all elements.

Direct operating costs have been figured at 1¢ per passenger-mile (200-lb. payload unit) at a 300-mi. range, 8¢ at ranges between 1,000 and 1,900 mi., and 1.1¢ per mile at 2,500-mi. range, in contrast to equipment now in service which costs 1.8 to 2½¢ per passenger-mile.

In other terms, the Stratocruiser will carry a payload of 30,000 lb. 500 mi. on 2,110 gal. of fuel; a payload of 19,200 lb. 2,500 mi. on 5,450 gal.; and 11,650 lb. 4,200 mi. on 8,225 gal. Included in each case is an 850-gal reserve.

Extra care has been taken to reduce ground time by providing for quick and easy handling of passengers and cargo, neither interfering with the other, and for ease of maintenance. Some of these features are a door on both the upper and lower deck for passenger use, a separate door for galley supplies, truck-bed-height cargo doors on the lower deck, an electric hoist and overhead rail for cargo movement to or from the upper deck, grouping of accessories for easy inspection and repair, and completely interchangeable power plants.

Review of Patents

(*Continued from page* 204)

changes in position, and resulting angular displacement of mast with respect to plane of rotation of inertia means is used to feather blades to cause rotor to remain uninclined or to tip in opposite direction to mast, thus causing restoring couple.—2,384,516, filed Nov. 10, '41, pat. Sept. 11, '45, A. M. Young, assignor to Bell Aircraft Corp.

Aircraft Design is intended to permit craft to take off vertically, and at sufficient height to be maneuverable into inclined position, and thus proceed, without loss of control in part as helicopter and in part as airplane, in generally horizontal direction at moderate speed. Craft is finally maneuverable into more greatly inclined

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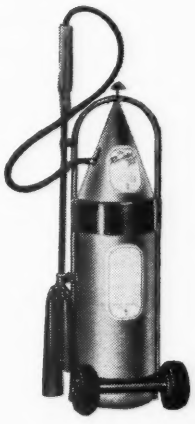

A dry, non-toxic gas, carbon dioxide cannot damage equipment or conduct electricity. It leaves no stain or liquid—no shut-down from water damage.

See, by actual demonstration, how fast-action Randolph "2", "4", "15" or "25" can mobilize and simplify *your* fire defense. For fire protection guidance and prompt delivery of equipment, call your nearest supplier, or write—

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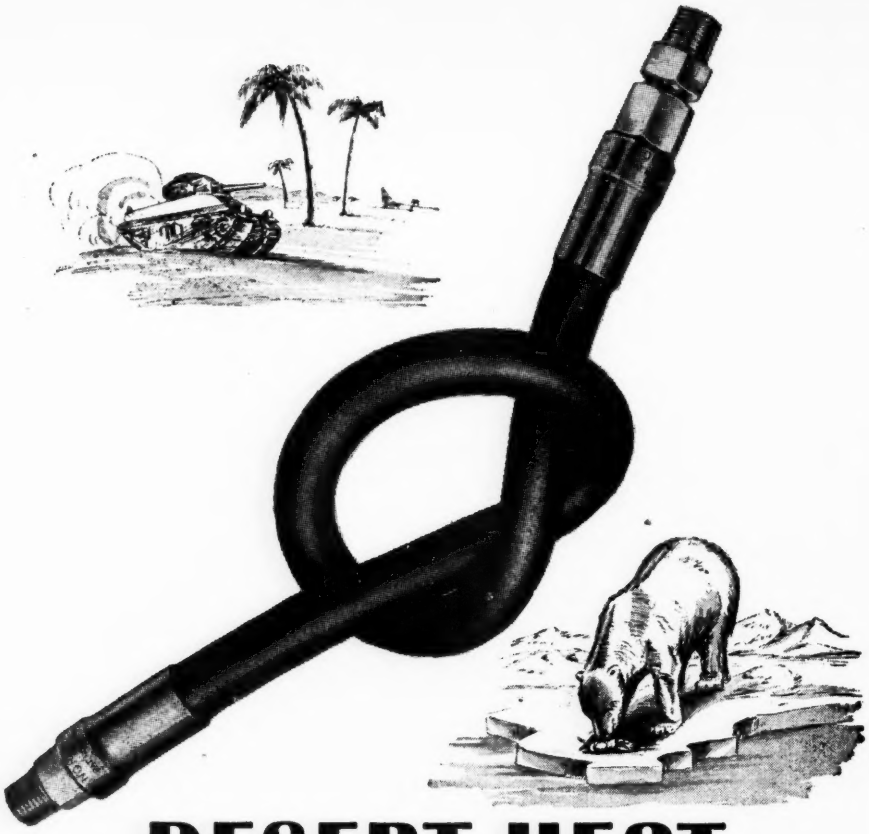

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Constructed of tough, wear resistant synthetic rubber hose, reinforced with woven high-tensile steel wire. Combine flexibility of rubber, strength of steel and oil resistant qualities of synthetics.

Fitted with machined brass couplings—permanent for high pressures, reusable for low pressures. Will not leak up to bursting point of hose. Stays put under extreme vibration.

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Norgren

position until main axis is horizontal and craft is flying at high speed as an airplane with thrust supplied by what were lifting propellers and lift supplied by wing.—2,382,460, filed Jan. 8, '41, pat. Aug. 14, '45, A. M. Young, assignor to Bell Aircraft Corp.

Method of Skin Blanket Attachment contemplates series of channel members serving to support skin sheet and having inwardly extending flanges or face portions. Channel members and their flanges run spanwise of skin sheet, and adapted to be disposed and secured between adjacent flanges of two adjacent channel members is tubular strengthening stringer. For attachment of skin blanket assembly to rib structure, attaching clips are provided, adapted to be attached to inwardly extending flanges and extend into face-to-face engagement with a side face or cap-strip of rib assembly.—2,382,950, filed Sept. 14, '42, pat. Aug. 14, '45, M. Watter, assignor to Edward G. Budd Mfg. Co.

Control Mechanism, intended to provide aileron droop without loss of aileron control at time of landing and takeoff, has automatic means selectively responsive only to movement of lower flap of split flap installation, but ineffective when flaps are split. Toggle link arrangement, between divided links adapted for respective connection to ailerons, is connected to the flaps so that when lower flap is lowered by usual flap-operating mechanism, movement will be automatically imparted to toggle links and thence to connecting links to droop the ailerons.—2,376,871, filed May 19, '43, pat. May 22, '45, M. Le R. Stoner, assignor to Curtiss-Wright Corp.

Aircraft Power Plant System includes plurality of prime movers, one or more of which may be disconnected from propulsive unit and maintained in condition for quick supply of power. When one engine is operated, idle engine may be disconnected from power shaft by automatic clutch but continues to receive hot gas from exhaust to keep it warm, so that idle engine may be connected at any instant for furnishing full power.—2,382,343, filed Jan. 9, '42, pat. Aug. 14, '45, E. A. Stalker, assignor to The Dow Chemical Co.

Recent Books

(*Continued from page* 204)

plete breakdown of the new Civil Air Regulations is given in question and answer form. Appendix specifies the flight maneuvers required of the private pilot under the new regulations.

HANDBOOK OF NONFERROUS METALLURGY, Donald M. Liddell, Editor-in-Chief. McGraw-Hill Book Co., New York City. 656 pages, photos, charts, graphs, index. $6.50.

This second edition is the first part of a two-volume handbook giving principles, methods, and data for the practicing metallurgist. It contains a comprehensive treatment of those operations, and of the apparatus and methods fundamental to the branches of nonferrous metallurgy.

A. S. T. M. STANDARDS ON PLASTICS. American Society for Testing Materials, Philadelphia. 542 pages, index. $2.75.

Sponsored by Committee D-20 on Plastics, this compilation dated May, 1945, gives 109 test methods, plus specifications, recommended practices, and definitions covering a wide range of plastics and related materials.

UNDERSTANDING LABOR, by Bernard H. Fitzpatrick. McGraw-Hill Book Co., New York City. 179 pages, appendix. $2.

An analysis of labor phenomena in the work-a-day world for those who would understand the meaning of various contradictory forces in the realm of labor.

THE VELOCITY-TRIANGLE COMPUTER IN PRINCIPLE AND PRACTICE, by S. A. Walling and J. C. Hill. Cambridge University Press, The Macmillan Co., New York City. 36 pages and computer. $2.

This handbook together with mechanical computer pertain to the quick solution of avigation problems for purposes of training the pilot-avigator in his approach to regular service computers. Presented are various problems which are solved by use of the included computer.

BRIEFING

Every year, the judges tell us, the job of picking out any two airlines for our Annual Maintenance Awards is more than tough, because every line in the country is constantly doing a magnificent piece of work. That reason made this year no exception, they report. But pick two they did—one flying up to 10,000,000 revenue miles, one flying more than 10,000,000—and the citations for the '45 champs will be found on page 110. Incidentally, *Air Transport* joins forces with us this year in tendering these Maintenance Awards, the 9th such presentation to be made.

As is customary with this issue, we have a greatly expanded Maintenance section, and it's of across-the-industry interest, for the feature articles offer a wide range of sound ideas for airline, military, and personal operations. This complete section is bulwarked by 15 pages of Maintenance Notebook presented in color, giving practical time- and money-saving ideas with the same industry-wide interest. A special Maintenance table of contents is on 109.

Never before in history has a nation dared appoint a group of civilians to go into a vanquished country to find out precisely what its conquering armies had accomplished. But that's exactly what happened with these United States when the late Pres. Roosevelt established the United States Strategic Bombing Survey—a group of twelve citizens—to determine the effects of airpower. A completely dispassionate job of fact-finding they did, and the results are must reading for anyone who is interested in maintaining peace on earth, goodwill toward men. Prime parts are digested on page 106.

Interest in the injection carburetor has been great, as is natural for such an advanced development, yet it's been impossible to tell much about it because of military security. But, we're pleased to report, the door has now been opened, and we present the first details on the construction and operation of Bendix' new type, which is adaptable for small civilian planes as well as military and commercial craft. This article starts on page 153.

Another development just coming back from the war is the new controllable pitch propeller developed for lightplanes and now being marketed by Beech. The engineering details and illustrations will be found on page 175.

And speaking of lightplanes, three new personal jobs are presented this month —the Stinson Voyager 150, on page 184; the new Culver V, on page 186; and the new Globe Swift, on page 187.

The ambitious man who wants to get going right now in this aircraft sales and service business—but who is balked by the lack of money required to build a complete new airport—will find plenty to interest him in the article beginning on page 178. For there, Donald Cooke lays down the principles for establishing floatplane bases, showing how money can be saved with this type of operation.

Plenty of people who are *in* Wall Street as well as away from it have been baffled by the course of stocks these last few months. Our Financial Editor this month looks into the airline securities situation and plots a probable course as the result of changing load factors, new financing, and other influences. His keen analysis is on page 195.

Aviation's next Briefing page will introduce Volume 45, the first of the New Year, which we sincerely hope will be the very best you've ever had.

K. H. Holmgren, Associate Director of Aviation Associates and the Aviation Institute of Professional Sales Training. He gives the details (page 176) of a new home training course for aviation sales work. That the merchandising know-how to be gained from such study will be essential in this aircraft sales and service business is indicated by the fact that the course he describes has already been put into use by Aeronca, Piper, and Taylorcraft, the lightplane "Big Three."

Down the Years in AVIATION'S Log

25 Yr. Ago (1920) — Capt. Corliss C. Moseley wins Pulitzer Trophy, flying Verville-Packard biplane at 178 mph. . . . Fokker puts out 7-passenger cabin transport to cruise at 110 mph. . . . Lakehurst dirigible hangar, world's largest, completed. . . . Airmail flies 116,023 mi. in month at cost of 63¢ per mile. . . . Pacific Fleet plans record 6,500-mi. seaplane round-trip run to Panama. . . . Argentina finds aviation control laws necessary. . . . Zeppelin builds 4-engine transport plane.

15 Yr. Ago (1930) — Nine-month plane output by 296 U. S. companies totals 2,154 craft. . . . Civil aircraft flew 68,669,928 mi. in first half of year with six fatal accidents. . . . PAA extends service to Para, Brazil. . . . Ford reports that private air freight service, Detroit-Chicago and Detroit-Cleveland-Buffalo, carried 10,000,000 lb. of freight during past five-year operation. . . . Capt. Hawks flies J6-9 Travel Air "Texaco 13" Havana-N. Y. in 8 hr. 44 min. . . . Capt. Ammel of Chicago flies Wasp-powered Lockheed Sirius N. Y.-Panama in 24 hr. 35 min., first non-stop flight. . . . French Government gives safe flying prize to Compagnie Generale Aeropostale pilot who flew 49,000 mi. in six months without accident.

10 Yr. Ago (1935) — German military aircraft production set at 3,000 per year. . . . Italy opens first International Aircraft Salon at Milan. . . . RAF sends pilots to U. S. for instrument training. . . . Raymond Schwartz of Boeing flies his first 23 hr. of instruction entirely by instrument. . . . Curtiss-Wright builds amphibian with nose wheel. . . . Kellet produces first wingless autogiro. . . . Naval Aircraft Factory turns out first XN3N-1 trainer powered by Wright J-5.

Safety Signal for Smart Pilots

The ability to control a plane with *precision* during landing, take-off and similar maneuvers is one of the biggest thrills in flying. And the sooner you learn to depend on instruments —reliable instruments—the quicker you'll master that control. More than two-thirds of all light-plane accidents are due to faulty human flying judgment. In many cases, *a glance at the instrument panel* would have corrected that judgment, saved a plane, saved a life.

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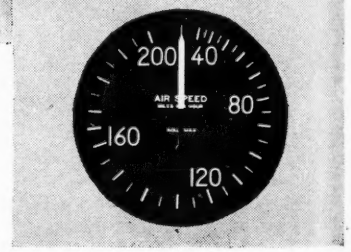

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CONTROLLED ATOMS or CONTROLLED LIVES

SINCE August 6th when the first atomic bomb was released over Hiroshima, the American people have been subjected to a continuous barrage of pronouncements on the use and control of atomic energy. Some of this comment has been strident, and much of it conflicting. A considerable portion of it has been of sincere and constructive excellence.

It has not been easy to separate the wise counsel from the merely noisy, and it is small wonder that the minds of many are troubled and confused.

However, the sheer mass of discussion poured into press and microphone has awakened us all to the gravity of the issue. In terms of any problem on which Americans ever have been called to exercise a judgment—This is It!

Even the dullest now recognizes that atomic weapons hang over modern civilization like the Sword of Damocles, and understands in some measure how fragile and taut is the hair of political balance that holds it suspended.

From this point on, we need the coolest and most carefully considered judgment that can be brought to bear. Discussion highly charged with emotionalism will but increase the tensions both at home and abroad, and render wholly insoluble a delicately intricate problem.

What Is The Problem?

The major outlines of that problem now are coming into focus in understandable terms:

1. The scientists have opened up a new and virtually unlimited storehouse of energy, and the engineers have discovered how to turn it into a military explosive incomparably more powerful than any we have known. We know that this energy may also be used to produce heat for useful power, and we suspect that the radioactive substances produced by the process in hitherto unimagined quantity may also have medical, industrial, and other constructive applications.

2. Terrifying as have been the demonstrations of the atomic bomb thus far, we know that they are as nothing in comparison with its potential destructiveness. The explosive force of individual bombs can be increased tremendously, and means for their effective delivery to predetermined targets in wholesale quantity already are at hand. The experts tell us that no practicable means of interception can be devised, and that reprisal in kind probably will be the only answer to an enemy attack with atomic weapons.

3. So far as we can see now, even successful retaliation would be at best an answer of hollow effect. Any two nations each having wholesale stock-piles of bombs could accomplish the practical destruction of each other. Since a first treacherous blow might well constitute an enormous advantage, a nation actuated by a ruthless urge to conquest or revenge might have the best chance of survival. But since the widest possible dispersal of bombs and launching units would be dictated by the strategy of atomic weapons, it is doubtful that one nation could destroy another without itself suffering destruction. On both sides the major centers of population could be wiped out, and the nation of least concentrated industrialization and commerce would suffer least. However, no one can be sure that the concentrated explosion of as many as 20 thousand atomic bombs would not poison the atmosphere of the world to an extent that would be fatal to great masses of population, not only within the country bombarded, but perhaps in the country which launched them.

4. The problem is further complicated because, so far as we know now, any large-scale commercial use of atomic energy as a power source is more or less inextricably linked to a potential military use. It is true that, if atomic power becomes economically feasible (which is by no means certain for a long time to come), it would require only low-grade concentrates of fissionable material, which would need further elaborate and costly processing before reaching explosive potential. But the process of producing such low-grade concentrates constitutes perhaps two-thirds of the industrial effort required to make effective bombs. It follows, then, that if nations were to equip themselves to produce large quantities of low-grade concentrates for power generation, the effort required to develop large-scale bomb production would be materially reduced. Moreover, the maintenance of an effective inspection to police agreements not to produce bombs might be forbiddingly difficult if atomic power generation were allowed.

5. In addition to the major problem posed by the use of atomic bombs in international war, any nation which produces or possesses such bombs, or the fissionable materials with which they are loaded, faces still another in the danger of their falling under the control of paranoid elements in its own population.

What Are We Going To Do About It?

We face the hard fact that we have produced a weapon capable of destroying whole nations—perhaps even the whole world. Although we were importantly aided in its development by the nationals of other countries, we, together with Great Britain and Canada, now must take the initiative in deciding what shall be done with it. We have only two choices. We can try to keep this weapon as a monopoly of our own, or we can try to place it under broad international control.

Can We Keep It To Ourselves?

If we know one certain fact about the atomic bomb, it is that it cannot long be held as a monopoly of those nations which produced it.

If Nazi Germany had succeeded in developing the weapon first, it probably would have attempted to achieve world dominion, with utter destruction as an alternative. Such a course is not within our range of choice. It violates every principle for which we stand.

Much reckless nonsense has been uttered concerning the inability of other nations to master the scientific, engineering, and industrial problems involved. It is the virtually unanimous opinion of those who worked on the project that several nations today are fully equipped in science, engineering, and industrial organization to produce atomic bombs and to provide the means for launching them. At least one of these nations, Russia, has also access to an ample supply of the necessary raw materials. The only debate is over whether it would take three, or five, or ten years for her to marshal her resources to produce bombs in multiple thousands. Once such an atomic race were on, we have no reason to believe that Russia might not divert more resources to the task than we ourselves should be willing to put into it.

Additional nonsense is talked as to how we might attempt to cope with the problem of living in a world in which mutually suspicious or hostile nations faced each other, with stores of atomic weapons on both sides. We hear talk of dispersing our cities and even of moving underground. No one has seriously reckoned the difficulty or the cost of following such counsel of despair. Still less has anyone appraised the neurotic effect upon men's minds of living by any such preposterous formula, under continuously mounting tension day after day, and year after year.

Certainly, if we could find no way to prevent the competitive production of atomic weapons, we should be driven at least to the selective dispersion of our bomb-launching facilities, of certain key industrial establishments, and of our centers of government and governing personnel. We should be forced, also, to change our traditional requirement that only Congress can commit us to active war. We should be forced to organize ourselves as a police or military state, with our scientists regimented and muzzled, with all of us under constant surveillance against the smuggling and planting of time-bombs, and constantly alerted against attack through the air.

Before we commit ourselves to any such intolerable procedure, we should be mad not to explore all possible means for making it unnecessary.

The Only Feasible Alternative Is Effective International Control

This cardinal principle has been recognized in the statement of November 15th, issued jointly by President Truman, and Prime Ministers Attlee and King. Their statement frankly concedes that against atomic weapons there can be no adequate military defense, that no nation can command a monopoly of such weapons, that responsibility for eliminating atomic energy as an instrument of war and for devising safeguards over its use for the advancement of science and other peaceful and humanitarian ends rests upon the civilized nations of the world.

They propose that a commission be set up at once under the United Nations Organization to make recommendations: (a) for extending between all nations the exchange of basic scientific information for peaceful ends, (b) for control of atomic energy to the extent necessary to ensure its use only for peaceful purposes, (c) for the elimination from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction, and (d) for effective safeguards by way of inspection and other means to protect complying states against the hazards of violations and evasions.

Already criticism is leveled at the wording of the statement, at alleged omissions, at the wisdom of choosing the United Nations Organization as the medium through which to seek agreement in view of the weaknesses of the UNO Charter.

None of these issues should be crucially important. What matters is that an invitation has been issued in good faith for the nations of the world to meet and decide upon means for assuring the elimination of weapons, the existence of which no one can afford to tolerate.

The decision cannot be other than international; it will require the best thought of the best brains the world can muster. The smaller nations have an equal stake with the large, and from them may well come the most fruitful suggestions. But Russia now holds the key to the success or failure of our proposal. If she accepts our invitation, no other nation will refuse.

Alternatively, there will be an international armament race paced by atomic weapons. It will mean an end of free science, a severe policing and regimentation of international travel and trade, and innumerable restrictions upon those individual freedoms which we have just fought so desperately to preserve. This is the dismal prospect if we fail to arrive at a genuinely international accord on the control of atomic energy. But even this interval would promise to last only for an uneasy period, until someone started pressing the push-buttons on the panel-boards of extinction.

The only permanent solution lies in finding means to eliminate war itself. That we cannot hope to achieve overnight, but we can, and do hope that the nations will now agree to eliminate atomic weapons and their radioactive by-products as instruments of war.

If they do that, we can move forward more surely to the constructive development of the incalculably valuable resources that science has newly opened to our use. And, we can hope also for a progressive improvement in international understanding.

Unless the nations can reach agreement on this paramount issue of atomic energy, it is difficult to conceive of any vital issue on which they might agree.

President, McGraw-Hill Publishing Co., Inc.

EDITORIAL

Reconversion to Re-Complacency?

THE RECENT Army-Navy-Commerce report on the demobilization of the aircraft industry is a thoroughly competent study and its framers deserve high commendation. Its recommendations envision a shrinkage to from 5 to 10 percent of 1944 production volume after the industry rebounds from the present doldrums, which may last through 1946. Wisely it views with alarm the current level of aviation procurement and emphasizes the necessity for a vigorous program of research and development. The whole report is based on the assumption that we shall have at least one year of warning of the possibility of attack.

Perhaps this calls for a little reflection upon just what constitutes warning. We were warned of Japanese ambition when Manchuria became Manchukuo. When Italy invaded Ethiopia we were warned again. When Germany began to infiltrate westward we had another warning. When aviation observers reported on German rearmament the warnings became stern and the men who sounded them were accused of Nazi sympathy.

The international armaments race that kept the aviation industry alive, when Army and Navy funds were unavailable for planes, should have been enough of a warning. And just what did we do about all of these warnings? We promptly cut our appropriations to the bone a few short weeks before Poland was invaded. Never before have so many warnings been heeded by so few.

It is easy to recognize a warning when we are looking backward, but we as a nation have demonstrated complete inability to discriminate between rumblings and warnings when we look ahead. And there is no reason to believe that we will improve in this respect.

Weapons have become so deadly that the only salvation for this civilization lies in international accord. But that doesn't mean that we should voluntarily relinquish our first place in arms to set the example for the rest of the world. It simply doesn't work that way and it is time we realized it.

AT THIS MOMENT IN HISTORY we are able to conquer any nation or any combination of nations. We do not choose to do so. But the power we now possess provides us with a temporary security, hence for a little while we need not fear war. But our present security is only momentary, and the kind of complacency we now feel is the same sort of thing that has led to the fall of empires since the days of the Sumerians.

The rapid demobilization of our air forces and our aviation industry is simply an invitation to other nations to catch up and exceed us in air power. Reserve officers who have done brilliant work in research and development are leaving our armed forces in alarming numbers. Provision for continuation of their work is often lacking. Important strands in the fabric of basic research are being cut daily, distorting the complex pattern of aeronautical science.

It is all well and good to exhort the industry to pursue its technological development work vigorously, but the present level of procurement does not justify the degree of development essential to keep our country abreast of the worldwide race for more effective weapons. And make no mistake. This race is still going on.

LET'S BE REALISTIC about the democracy we have won and which we love so well. We know it is the best way of life, but we should not forget that a democracy is slow to anger and slow to mobilize in an emergency. At the same time the tempo of life and war and destruction has increased beyond the limits of human comprehension.

In the light of these cold truths it seems simple logic to stop wishful thinking about getting a year of warning before the next attack. The least we can do for posterity is to set up a demobilization plan based on the assumption that we *shall* be attacked without any warning. Such a plan should be worked out immediately and submitted to the Congress before American people fall completely into that complacency that spelled ruin for Sumer, Greece, and Rome.

Such a plan should include a study of the location of plants and the advisability of underground factories. A new proportioning of aircraft types in the composition of our air forces must be considered, also the most effective use of guided missiles and atomic bombs. Let us, in shaping the weapons of a future war, carry on in those new fields of science represented by the striking weapons which were used to terminate the recent conflict.

Let us have a procurement program large enough to support industrial research and development and provide production pilot lines that can be expanded instantly—not within a year. And let us provide our air forces with the funds and personnel for the evaluation of new weapons in continuous tactical maneuvers.

Let us do all these things first. Then let us work incessantly for, and pray fervently for, a peace we can enforce.

Leslie E. Neville

EDITOR

Here is the
ALLIED BOMBING RECORD

• This "must reading" article, based on the United States Strategic Bombing Survey, contains essential parts of a military critique—first in history to be written by civilians—sharply defining a completely objective view of the part played by airpower in defeating Germany. As important, however, is its precise range-finding of the future, targeting in unequivocal terms the pressing need for a national policy of continued, coordinated aeronautical research and development.—The Editors

THE NEW RELATION of airpower to strategy presents one of the distinguishing contrasts between this war and the last. Airpower in the last war was in its infancy. The new role of three-dimensional warfare was even then foreseen by a few farsighted men, but planes were insufficient in quality and quantity to permit much more than occasional brilliant assistance to the ground forces.

Airpower in the European phase of this war reached a stage of full adolescence, a stage marked by rapid development in planes, armament, equipment, tactics, and concepts of strategic employment, and by an extraordinary increase in the effort allocated to it by all the major contestants. England devoted 40 to 50 percent of her war production to her air forces, Germany 40%, and the United States 35%.

Nevertheless, at the end of hostilities in Europe, weapons, tactics, and strategy were still in a state of rapid development. Airpower had not yet reached maturity, hence all conclusions drawn from experience in the European Theater must be considered subject to change. No one should assume that, because certain things were effective or not effective, the same would be true under other circumstances and other conditions.

In the European War, Allied airpower was called upon to play many roles—partner with the Navy over the sea lanes; partner with the Army in ground battle; partner with both on the invasion beachheads; reconnaissance photographer for all; mover of troops and critical supplies, and attacker of the enemy's vital strength far behind the battle line.

In the attack by Allied airpower, almost 2,700,000 tons of bombs were dropped, more than 1,440,000 bomber and 2,680,000 fighter sorties were flown. The number of combat planes reached a peak of some 28,000 and at the maxium 1,300,000 men were in combat commands. The number of men lost in air action was 79,265 Americans and 79,281 British*. More than 18,000 American and 22,000 British planes were lost or damaged beyond repair.

In the wake of these attacks are great paths of destruction. In Germany, 3,600,000 dwelling units, approximately 20 percent of the total, were destroyed or heavily damaged. Survey estimates show some 300,000 civilians killed and 780,000 wounded. The number made homeless aggregates 7,500,000. The principal German cities have been largely reduced to hollow walls and piles of rubble. German industry is bruised and temporarily paralyzed. These are the scars across the face of the enemy, the preface to the victory that followed. The use of airpower cannot properly be considered, however, except in conjunction with the broad plans and strategy under which the war was conducted.

Interrogation of Hitler's surviving confidants and General Staff and Field Generals of the Wehrmacht confirms the view that prior to the winter of 1941 Hitler hoped to realize Germany's ascendancy over Europe, and possibly the world, largely by skillful strategy. Time and timing were the secret weapons in the German war plan that took shape after 1933. Hitler hoped to build Germany's strength more quickly than that of any potential opponent. By rapid mobilization of a powerful striking force, by exploiting the political and ideological strains that he conceived to exist in the rest of the world, and by overwhelming separately in lightning campaigns such of his enemies as chose to resist, he hoped to secure for Germany an invulnerable position in Europe and in the world.

What Germany lacked in numbers of divisions, in raw materials and basic industrial strength, it planned to compensate with highly trained ground units of great striking power. These were to be equipped and ready to march while Germany's enemies were merely preparing. Essential in this strategy was a technically well-developed air force in being. Emphasis was not placed on development of an air force that would destroy the sustaining resources of the enemy's economy. In the German plan it was anticipated that an enemy's entire country would be so quickly overrun that little concern need be had for industrial and war production that was merely potential. The air force was, primarily, an arm of the blitzkrieg.

The success of Hitler's strategy, until the battle of Britain, was complete; his more cautious advisers and generals still confess to their astonishment. And by common report of the surviving Nazi leaders even the setback over Britain was considered of minor importance. The attack on Russia was next on the calendar—the

* All RAF figures are preliminary or tentative.

decision to make this attack was taken in the autumn of 1940—and this, according to plan, was to be a brief four-months' adventure. There would be time thereafter, if necessary, to deal with Britain. By Sept., 1941, Hitler was so confident that he had succeeded in Russia that he ordered large scale cut-backs in war production.

In both the RAF and the U. S. Army Air Forces there were some who believed that airpower could deliver the knockout blow against Germany, and force capitulation. This view, however, was not controlling in the over-all Allied strategic plan. The dominant element in that plan was invasion of the Continent, to occur in the spring of 1944. Plans called for establishing air superiority prior to the date of the invasion and the exploitation of such superiority in weakening the enemy's will and capacity to resist.

Deployment of the air forces opposing Germany was heavily influenced by the fact that victory was planned to come through invasion and land occupation. Early in the war, to be sure, the RAF had the independent mission of striking at German industrial centers in an effort to weaken the German people. However, the weight of the RAF effort, compared with tonnages later employed, was very small—16,000 tons in 1940 and 46,000 tons in 1941, compared with 676,000 tons in 1944.

Soon after the United States entered the air war in 1942, replacements for the new (and still small) 8th Air Force were diverted to support the North African invasion. During 1943, target selection for the 8th Air Force and the 15th (based on the Mediterranean) reckoned always with the fact that maximum contribution must be made to the invasion in the coming year. And the 9th Air Force in Western Europe and the 12th in the Mediterranean were developed with the primary mission of securing the sky and clearing the way for ground operations.

In the spring and early summer of 1944, all air forces based on England were used to prepare the way for the invasion. It was not intended that air attacks against Germany proper and the German economy would be a subordinate operation, but rather a part of a larger strategic plan—one that contemplated that the decision would come through the advance of ground armies rather than through airpower alone.

The pioneer in the air war against Germany was the RAF, which experimented briefly in 1940 with daylight attacks on industrial targets in Germany but abandoned the effort when losses proved unbearably heavy. Thereafter, it attempted to find and attack such targets as oil, aluminum, and aircraft plants at night. This effort too was abandoned; with available techniques it was not possible to locate the targets often enough. Then the RAF began its famous raids on German urban and industrial centers. On the night of May 30, 1942, it mounted its first thousand-plane raid against Cologne and two nights later struck Essen with almost equal force. On three nights in late July and early Aug., 1943, it struck Hamburg in perhaps the most devastating single-city attack of the European War—about one third of the houses of the city were destroyed and German estimates show 60,000 to 100,000 people killed.

No city raid shook Germany as did that on Hamburg; documents show that German officials were thoroughly alarmed and there is some indication that Hitler himself thought further attacks of similar weight might force Germany out of the war. The RAF proceeded to destroy one major urban center after another. Except in the extreme eastern part of the Reich, there is no major city that does not bear the mark of these attacks. However, no subsequent attack had the shock effect of the Hamburg raid.

In the latter half of 1944, aided by new avigational techniques, the RAF returned with part of its force to attack industrial targets. These attacks were notably successful, but it is with the attacks on urban areas that the RAF is most prominently identified.

City attacks of the RAF prior to autumn, 1944, did not substantially affect the course of German war production—as a whole it continued to increase. This in itself is not conclusive, but the Survey has made detailed analysis of the course of production and trade in ten German cities attacked during this period and has made more general analyses in others. These show that while production received a moderate setback after a raid, it recovered substantially within a relatively few weeks. As a rule industrial plants were located around the perimeter of German cities and characteristically were relatively undamaged.

Commencing in the autumn of 1944,

(*Turn to page* 261)

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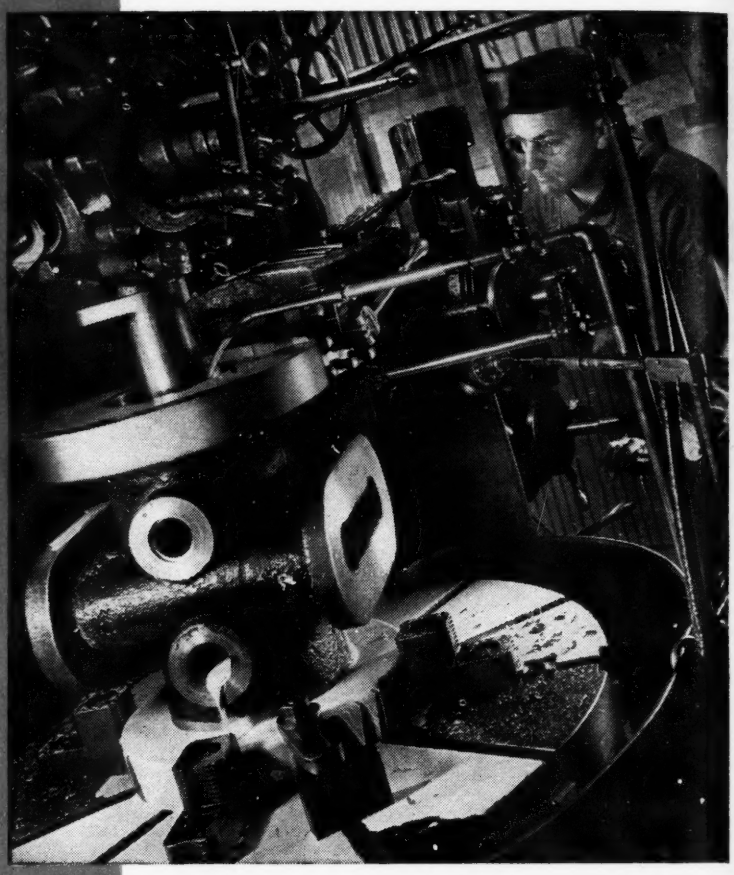

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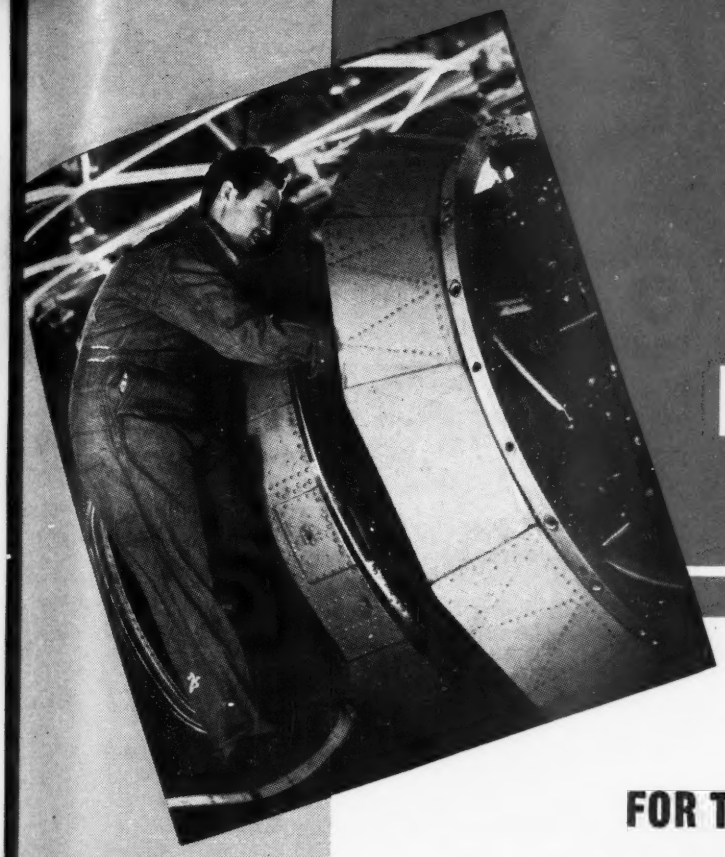

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AVIATION AND AIR TRANSPORT

These, the 9th Annual Maintenance Awards, are presented as a tribute to the unsung members of the airlines groundcrews, the men and women who have worked untiringly and unspotlighted to make immeasurable contributions to the constantly greater scheduled air transport safety and efficiency—safety and efficiency which have made America's air carriers unparalleled as a vital part of the nation's victorious war machine as well as its peacetime economy.

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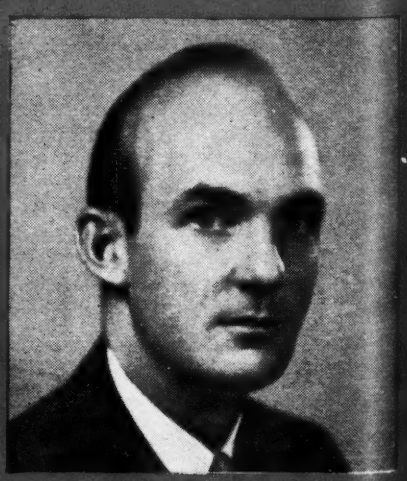
and its Maintenance Department headed by Hubert G. Lesley



HUBERT G. LESLEY

1945 MAINTENANCE AWARDS

This year AVIATION is more than proud to be joined in making the Maintenance Awards by its companion publication, AIR TRANSPORT. As has always been the case, these awards are made on the basis of the decision of the judges, who report that every airline in America has every right to be more than proud of the outstanding work of its maintenance department.

DELTA AIR LINES

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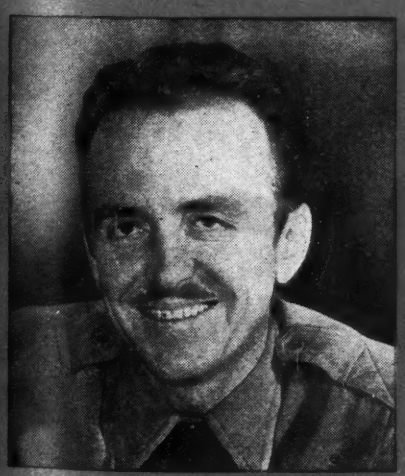
and its Maintenance Department headed by G. J. Dye.



G. J. DYE

Retraining Is the Answer

AS MAINTENANCE "GOES DIVERSE"

By **ALBERT G. THOMAS,** *Maintenance Training Superintendent, and*
ALLAN MERKIN, *Maintenance Publications Editor, Atlantic Div., Pan American World Airways*

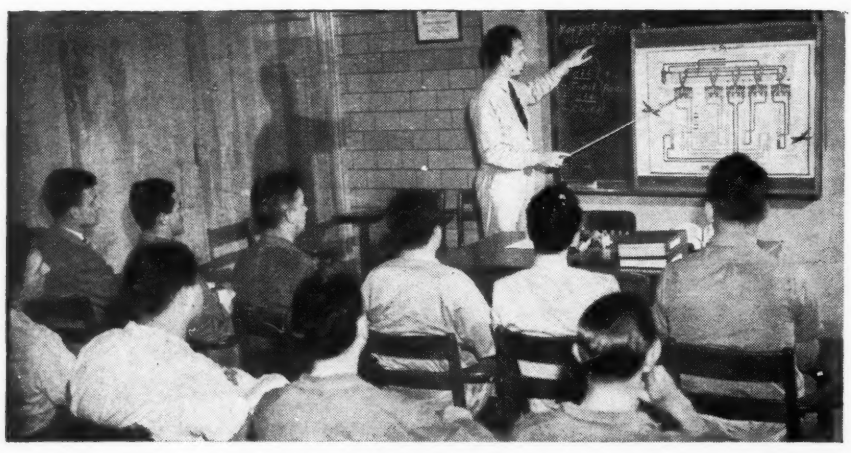
Different types of craft the airlines are now acquiring, after the long war years, bring pointed problems—of mechanic re-training and of shop re-planning to attain efficient simultaneous performance of diversified maintenance . . . Here's how PAA's Atlantic Div. worked its solution.

AIRCRAFT MAINTENANCE — always the backbone of airline service—is more brightly spotlighted today because of the critical craft-type transition stage facing virtually every commercial air carrier.

In the process of changeover from old craft to the newer, larger, and more heavily powered planes not available during the war, and in the haste to get these new carriers into operation to meet increased air traffic, the diversity of maintenance procedures involved in simultaneous servicing of various types of craft is a prime airline problem with many ramifications.

Currently, the consideration of efficient and economical performance of diversified maintenance is facing many airlines, and eventually all will have to tackle the problem. For though it may be basic policy for a carrier to standardize on the type of plane used, it probably will be some few years before this standardization can be realized—this because of the simultaneous and extensive demand for types currently available.

What the Atlantic Div. of Pan American World Airways at La Guardia Field has done and is now doing—particularly with respect to further training for maintenance personnel—in its transition to other type craft offers a basis of comparison for other airlines with similar problems and also a good working plan for those who will yet face them. PAA's transition problem is comparatively complex because of the contemplated changeover from Boeing B-314 flying boats to landplanes—Douglas DC-4s, Lockheed Constellations, and Republic Rainbows. And while other airlines, in the main, will switch from one landplane type to another, their problems will not be different in kind but, rather, different in degree.



Classroom mockup demonstration affords practical study of hydraulic system hookup and operation. Various units may be mounted on removable panels and quickly connected into system.

First new craft received by PAA's Atlantic Div. have been DC-4s (C-54's from ATC). Initial task facing the company was to fit this type craft into its existing maintenance setup and utilize facilities to best advantage, so as not to disturb organization procedure or create personnel problems. This consideration was of extreme importance, since it was necessary, at the same time, to carry on current operations with a radically different type craft—Boeing flying boats.

Accordingly, a complete survey was instituted to determine what existing shop equipment would be suitable for modification so as to serve an overall usefulness, also what new equipment required could be fabricated on the premises, and what units would have to be purchased.

Involved were such items as:

(1) Workstands for airplane structures and engines.

(2) Ladders for entrance facilities.

(3) General servicing devices—jacks, slings, hoists.

(4) Ground handling equipment—tow trucks, chocks, and other auxiliary equipment. (Whereas heavy Diesel tractors were used for towing the flying boats, ordinary tow trucks could be used for landplanes. Also, beaching gear on the Boeings is self locking, and with the new planes, wheel chocks would have to be utilized. Moreover, in the old craft, surface control locks are incorporated in the control system, whereas with the DC-4's auxiliary clamps are necessary.)

(5) Special servicing and testing equipment. (The switch to another

Extent of diversity of maintenance now required in PAA's Atlantic Div. is revealed in this aggregation of various type craft being simultaneously serviced at company's La Guardia Field base—with ATC Douglas C-54 (foreground), Boeing B-314 (upper center), Douglas B-23 (far right), and Grumman G-21 (far left, behind B-314). Whereas only main base maintenance is performed on C-54, complete maintenance and repair is done on PAA's commercial version of craft (DC-4).

plane having various different accessories required special accessory tools, and new overhaul test equipment or adapters for application to existing test equipment so as to handle changes in operating pressures and fluid flows. And because it had not been required for maintenance of the Boeing flying boats, a completely new shop installation was established for repair of hydraulic system equipment, landing gear, wheels, tires, and brakes.)

(6) Emergency equipment. (Whereas large Foamite fire extinguisher generators on carts were required for the Boeing, the hand type of extinguisher serves for the landplane.)

(7) Stock supply. (This involved procurement of materials required for modification, maintenance, and repair of the landplane, also a complete stock of spare parts.)

Another preparatory phase — the most vital in the transition to DC-4s —was PAA's maintenance training program for the new servicing crews. This program, conducted by an established maintenance training section, was an extensive elaboration of existing instructional facilities, to meet the contemplated problems of servicing.

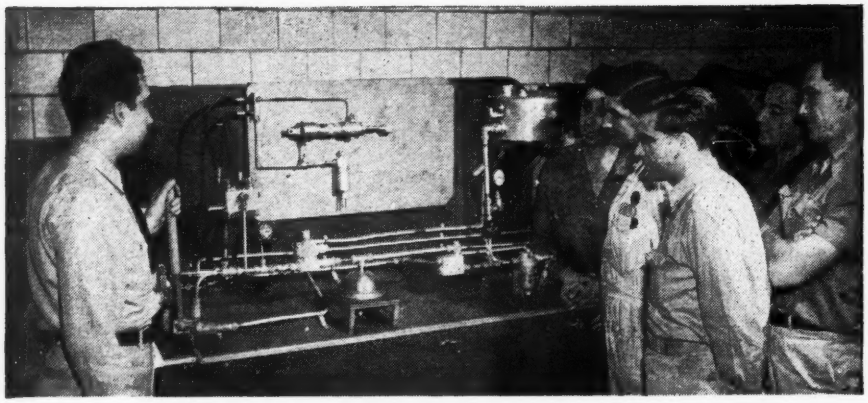
First consideration under this program—training of key personnel—had got off to a good start when PAA mechanics were first required to perform only main base maintenance on C-54s for the ATC, during the war years. The organization was combed for men whose experience and background would be particularly valuable in the new phases of maintenance—men who possessed sufficient basic qualifications to form a nucleus for training other mechanics. This survey resulted in the selection of 18 key mechanics and some maintenance specialists to attend a C-54 maintenance school conducted by PAA's Latin American Div. at Miami. Another group consisting of 3 instructors, 4 lead mechanics (crew chiefs), 4 service engineers, 5 inspectors, and 2 flight engineers were sent to the Douglas Santa Monica plant for special training.

And when it was first learned that a number of C-54s were to be turned over to PAA for its own commercial operation, it was necessary to prepare for efficient and economical performance of maintenance and repair of the entire airplane structure and every equipment component.

Accordingly, a picked crew of technicians was sent to the Douglas plant to observe structural procedures of manufacture and assembly, to learn particular installation details for the various units on the plane, and to obtain complete information about jigs, fixtures, and templates required for overall long-range maintenance. Also provided was an arrangement between Douglas and PAA to facilitate an interchange of information relevant to current changes and modifications.

In addition, to insure coverage of all maintenance details of engine and accessories, picked personnel were sent to manufacturers of these units for complete familiarization. Also gathered were charts, drawings, service manuals, performance and test data, and training films; and arrangements were also made with the various manufacturers for receipt of information relevant to maintenance and design changes on the equipment.

All this material was collated with various PAA maintenance procedures,



Classroom mockup demonstration affords practical study of hydraulic system hookup and operation. Various units on removable panels can be quickly connected into system.

digested, and incorporated into two types of maintenance manual—one of general nature concerned with practices acceptable in servicing all types of craft operated in the Atlantic Div., the other dealing with maintenance procedure for the specific craft, in this case the DC-4.

Serving as mechanics' handbooks, these manuals, arranged for easy reference, provide an official source of information relative to the proper practices to be followed in the maintenance of the company's aircraft. Before final preparation of the manuals, maintenance publication personnel collaborated with CAA officials to insure complete coverage, since approval by that organization of the contents would be necessary prior to obtaining permission for operation of the aircraft.

For efficient instruction of the mechanic force proper—numbering over 700—a survey was conducted to accomplish proper grouping. Some mechanics were necessarily retained for work on the flying boats; others were grouped according to aptitude and previous experience which would tend toward best results in servicing the new type of plane. Specially stressed, in the grouping for new assignments, was the selection of men who had demonstrated an ability to pass on knowledge to less experienced mechanics.

After it had been decided to what specialties the various mechanics would be assigned, classes were formed under the supervision of instructors who had visited the Miami Div., the Douglas plant, and establishments of the various accessory manufacturers.

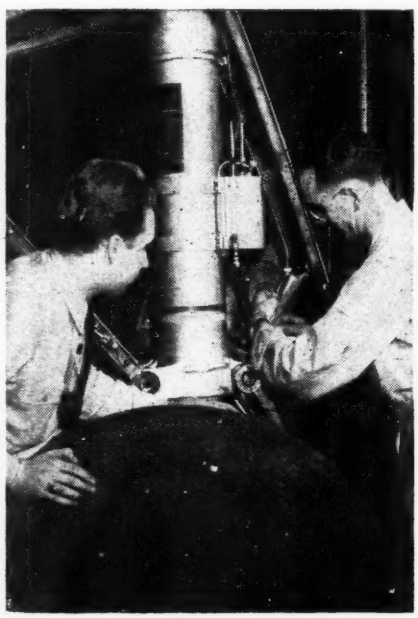
Aim of classroom instruction—about 72 hr.—was to afford a general familiarization with the new craft and insure a thorough understanding of particular specialties. This presentation of theory was considered essential for efficient trouble shooting, since without a clear conception of how a unit or system operates, location of trouble can frequently consume considerably more time than does the actual repair work.

Existing training mockups had to be modified to include new accessories and associated equipment, and new mockups—such as a hydraulic system—had to be built to adequately cover installations which were not found on the Boeing flying boats.

Lectures, coupled with practical demonstrations on equipment, were also presented by various factory representatives who visited the shop.

In addition to classroom instruction, the first DC-4 received for PAA's own use was set aside for a sufficient period of time to afford thorough on-the-job training, thus coordinating the theory presented in the classroom with practical procedure in the shop.

And upon completion of the instruction phase, mechanics were required to pass written and practical tests covering general and special aspects of the new craft.



Final phase of transition training is on-the-job instruction. These mechanics, assigned to landing gear maintenance, perform work as instructor keeps close check.

When finally assigned to an operating aircraft, maintenance crews are accompanied by their instructors to give further on-the-job training with special emphasis placed on standard procedures as specified in the company's maintenance manuals. To promote work standardization, job time and procedures were established after extensive observation by a job study group.

Another consideration in the transition maintenance program was the retraining of mechanics stationed at outlying bases. This called for sending trained replacements to relieve those coming to the main base for instruction.

After-study of shop facilities revealed that the extensive fabric and dope shop activities required for the flying boats could be greatly decreased for efficient maintenance of the DC-4's by combining this activity with the paint shop and training comparatively few painters to do the work. Also, it was found that activities of the metal working shop could be halved in the changeover from flying boat to landplane—because of less damage from corrosion and elimination of damage to hulls by floating objects. On the other hand, propeller shop maintenance was increased because of damage from flying gravel.

The various considerations of shop reorganization and instruction, found to be necessary as a result of the diversity of maintenance involved in the immediate transition to DC-4's, are also being applied to Douglas B-23's and a Grumman G-21 acquired by the Atlantic Div. for executive use, likewise Grumman G-44's, which are presently being used for instrument flight training prior to final testing on the DC-4.

And although the Lockheed Constellations have not yet been received, preparations similar to those made to cope with diversity of maintenance involved in the planes currently on hand are also underway for this craft—to insure that its acquisition will find maintenance crews ready and trained to service it.

As soon as feasible, preparations will also be made to train crews for servicing another type craft contracted for by PAA—Republic's Rainbow.

Noteworthy, too, is the cooperation afforded PAA personnel, during the training period, by other airline organizations at La Guardia. Instructors and crews were permitted to visit these base installations to observe maintenance procedures on landplane types, and on some occasions there was loaning of equipment to tide over emergencies.

Maintenance Principles FOR GAS TURBINE JET ENGINES

By JOHN FOSTER, JR., *Managing Editor, "Aviation"*

New type power plants bring new techniques requiring special training and continued ingenuity. Despite thermal unit's basic simplicity, need for careful and highly skilled work means maintenance man's job will be as vital as ever.

BECAUSE THE GAS TURBINE jet propulsion power plant is basically a very simple unit, its service and maintenance is, in some respects, much simpler than that required for reciprocating engines.

But, because the jet engine is a mechanical device, it has its own peculiar causes of trouble which require specialized training to overcome. Its extremely high speeds—up to 15,000 rpm—and close tolerances demand that an unsual degree of care and cleanliness be maintained; and its principle of operation calls for new procedures. Both these factors mean that the work of the maintenance man is just as vital for efficient and economical operation as it has ever been, in either military or civil aviation.

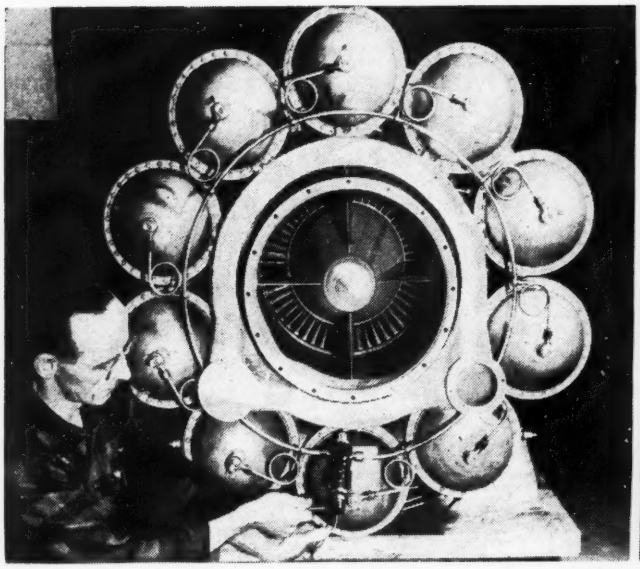
Both centrifugal and axial flow jet engines may be divided into five major components: The compressor and turbine, or rotor assembly; the compressor casing; combustion chambers; exhaust cone; and accessories. Each component naturally presents its own service and maintenance problems, but military secrecy still prevents a detailed discussion of specific American types.

The basic maintenance principles can, however, be discussed in general terms, as a means of pointing up what types of training and equipment will be increasingly necessary as this type of power plant comes into more general use.

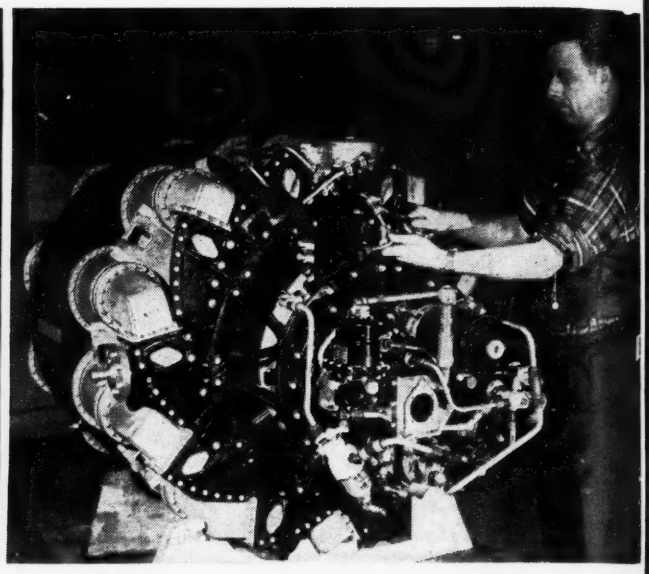
Disassembly procedures will, of course, vary according to manufacturers' instructions for each model, but American jet units appear to have been designed with some thought for facilitating the work of the maintenance man, something which can't be said for at least one German unit, the Junkers Jumo 004 (see page 128 Nov. AVIATION).

One of the most important features in overhauling the rotor unit is to insure proper balance of both impeller and turbine. Since, in present designs, these components cannot be replaced during post-overhaul assembly as a complete unit, they must be assembled outside the engine, checked for run out, dynamically balanced, then again

AAF mechanics give "in plane" inspection and service to GE jet engine in Bell P-59A at Wright Field. This new type power plant requires training in new techniques, but calls for same high degree of care exercised with reciprocating engines.



Checking fuel system on GE I-16 jet engine to insure even distribution of fuel to all combustion chambers, necessary for maximum efficiency. Note that turbine and exhaust cone can be inspected without further disassembly.



Jet engine accessories—shown here on front of engine—are very similar to types used on conventional reciprocating engines, thus simplifying this portion of maintenance procedures. Smaller number of accessories contributes to economy.

disassembled. Special balancing machines have already been made available, capable of showing unbalances of from 4 to 6 gram-in. for each .001 in. deflection.

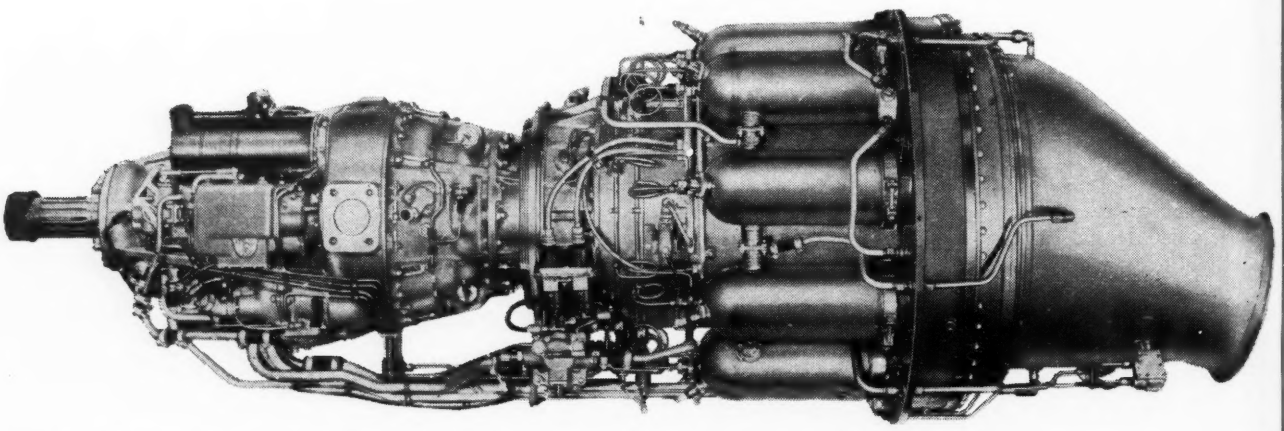
To give an idea of the extent of work necessary, balancing procedure such as is necessary on turbosuperchargers or other high speed rotors is outlined as follows: With the unit in the balancing machine, place a small piece of clay on the impeller between any two vanes near the periphery; run the rotor up through critical speed and check maximum spread of indicator; stop the unit and mark just below the clay the amount of unbalance. Then move the clay 90 deg. in either direction and repeat the process until four tests have been made. Starting with the lowest of the four readings, move the clay a short distance toward the next lowest reading and, if the readings show improvement, continue moving the clay until the lowest possible reading is obtained. At this point remove or add small amounts of clay as necessary to get the readings within the allowed tolerance.

This same process is repeated on the turbine, placing the clay just inside the turbine wheel's outer rim. Then metal equal in weight to the lump of clay must be removed from the opposite side of the unit. In the case of impeller, this is hand-filed out of the periphery between impeller vanes; in case of the turbine wheel it is removed by a hand grinder from the balancing ring which is just inside the turbine wheel rim. In each instance there are some limitations in both weight and location.

In the case of an axial flow compressor, each individual disk would have to be balanced separately, then the unit as a whole checked to insure proper balance.

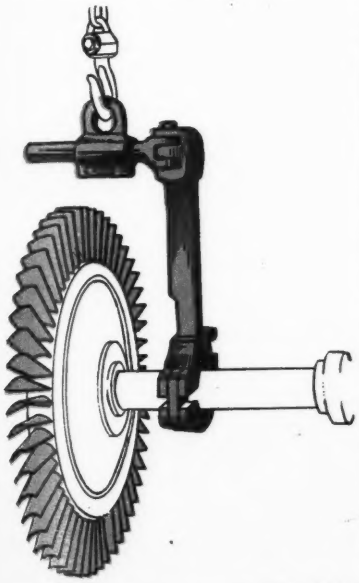
There are, of course, vital detailed procedures varying with different models of both axial and centrifugal types, that would add to or detract from the time necessary for such work; but the principles would remain constant, and the necessity for extreme care and cleanliness throughout the job would remain equally as important. Servicing and inspecting of bearings, for example, require at least the same care and precision as that essential for any other aircraft unit.

Clearances on jet engines, too, are extremely important and must be carefully watched. Impellers on centrifugal engines, for instance, must be meticulously adjusted for fore-and-aft clearances, sometimes with specially-built tools. Turbine nozzle shroud ring clearances must be carefully maintained; even exhaust cone clearances have to be kept within definite limits to make sure the engine will perform

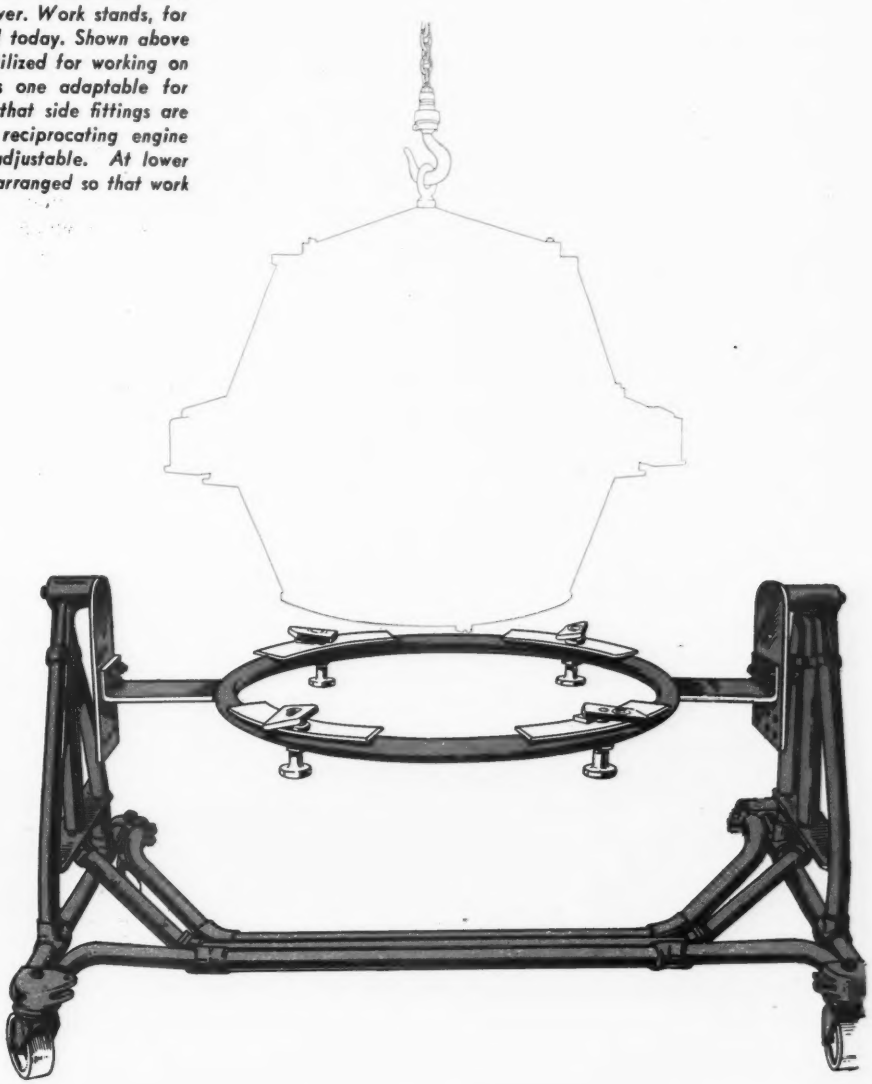


General Electric's new TG-100, gas turbine-propeller power unit which combines two types of maintenance, both of which require degree of skill which means maintenance man's importance will continue as great as ever.

Though many new maintenance techniques are required for jet propulsion engines, procedures and tools familiar to maintenance men can easily be adapted for this new form of power. Work stands, for example, can be very similar to those employed today. Shown above is artist's conception of stand which could be utilized for working on turbine and shaft assemblies, while at right is one adaptable for major tear-down and assembly. Note in latter that side fittings are adjustable vertically as are many of today's reciprocating engine stands, while circular plate at bottom is also adjustable. At lower right is shown another type of adjustable stand, arranged so that work can be rotated.



In many cases jet engine maintenance will bring special handling equipment and tools, such as rotor assembly carrier illustrated above. Note that joint at top is reversible so that unit can be used to carry either part of, or complete, compressor-turbine assembly.



as it should when properly handled.

Combustion chambers, being peculiar to jet engines, require their own specialized type of inspection and maintenance. In most cases daily inspection can be made without removing the engine from the plane. Such inspection consists of checking flame tubes or liners for excessive burning, warping, or cracking. This type of maintenance requires special training, because discoloration in the combustion chamber assembly is not necessarily a true indication that liners are burned, since they can be beyond safe operating limits without discoloration showing on the outer unit.

On some engines the normal inspection routine calls for removing only the lower combustion chamber assemblies to inspect the liners and, depending on their condition, deciding if it is essential to replace all liners.

In routine inspections, the fuel manifold assembly must, however, be removed for inspection in prescribed sequence, then examined carefully for cracks, structural flaws, or other damage. And, as is the case with reciprocating engines, great care must constantly be exercised to make sure that no dirt is allowed to get into the fuel system.

Overhauling the fuel system requires (in addition to the disassembly, inspection, and repair) a reassembly outside the engine for testing to make certain that the entire unit functions properly. This includes, for example, two types of tests: An idle pressure test to ascertain that all fuel nozzles are performing properly, and a flow balance test—which requires a flow balance stand—to make sure an equitable flow of fuel will reach all combustion chambers.

Typical of the care required in maintaining jet propulsion engines is that which must be given the exhaust tail cone. Apparently only a simple structure slapped together of sheet metal, it must nevertheless be kept in good condition, for it is in this area that all the turbulence of the expanding gas is converted into direct thrust. Thus the shape of the inner as well as the outer sections must be kept to true dimensions; also the clearances between turbine bucket tips and shroud ring must be within tolerances to avoid reworking or discarding the cone. Thus, even though it is a lightweight and unglamorous structure it can no more be tossed around than can close fitting cowlings for reciprocating engines.

Gas turbine jet propulsion engines have one distinct economy and time advantage over conventional reciprocating engines in that they require far fewer accessories. It is noted that one of America's best known types requires only the following attached accessories: Starter motor; tachometer; starting and main fuel pumps; lubricating and scavenge oil pump; governor; barometric pressure valve to maintain constant speed regardless of altitude; and lubricating oil filter. The accessory case of the Junkers Jumo 004, as another example, provides only seven outlets, at least one of which was found blanked off on several engines studied.

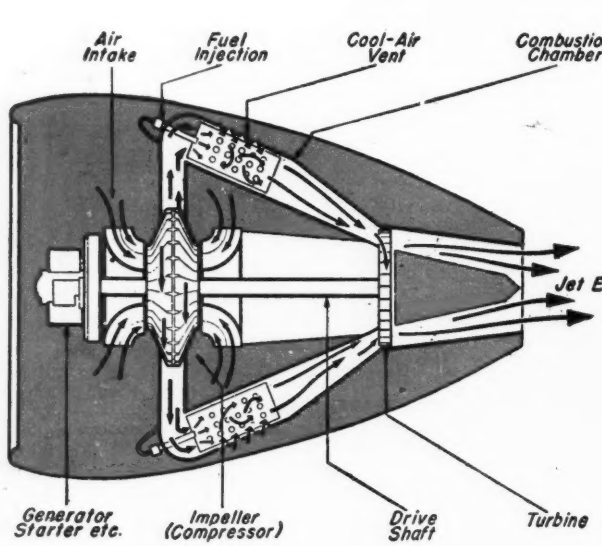
Too, these accessories are very similar to those employed on today's reciprocating engines, so maintenance personnel who understand the current units should have no difficulty taking proper care of those on jet engines. It is, largely, a matter of maintaining the same degree of precision and care which has always been fundamental to good maintenance.

It is patent that any shop undertaking jet engine service and overhaul will have to meet if not actually excel the high standards of cleanliness associated with today's successful overhaul base, for if cleanliness is next to Godliness in the reciprocating engine shop, it's practically the same thing as Godliness in the jet engine shop.

This quality is not only essential to maximum performance and life of the power plant, but it also serves to reveal damage which can imperil the whole unit. As a case in point, since jet engines generate terrific heat, any superfluous oil or grease must be kept away because, in addition to interfering with radiation of the heat, they create a fire hazard. Even selection of lint-free cloth for cleaning is essential, both for the high precision parts and the small metering orifices in the fuel system.

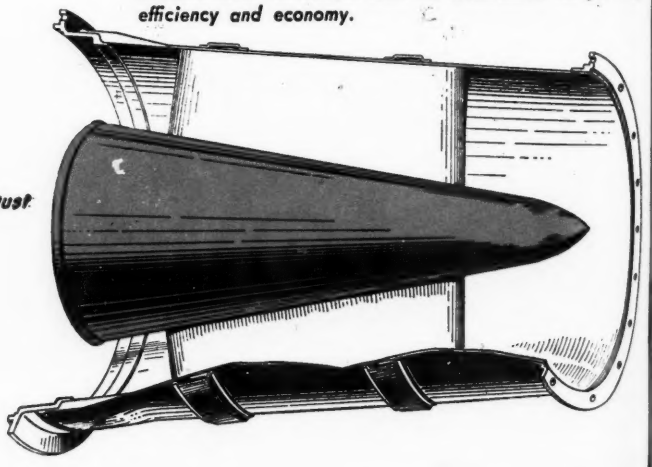
Because of the basic simplicity of the gas turbine jet propulsion engine, it should, as its design progresses to the point where it becomes a competitive factor in peacetime aviation, show lower maintenance costs than the complicated reciprocating engine. Trouble shooting, while requiring a high degree of skill, should be an easier and faster job simply because there are fewer sources of trouble to track down.

While today's overhaul consists primarily of tear-down and replacement of parts, the ingenuity of maintenance men is considered almost certain to further reduce costs by re-working, adapting, and continued use of the old reliable preventive maintenance. One thing is certain, though, and that is that highly skilled and ingenious maintenance will always be just as important to successful jet operation as it always has been with any other type of power plant.



Cross section indicating basic principles of GE Superjet—unit which powers Lockheed P-80 Shooting Star—showing major components requiring service and overhaul. Due to high precision of many parts, jet maintenance calls for same degree of cleanliness long associated with successful aircraft overhaul shops.

Although jet engine exhaust cones are basically simple structures, they demand as great care as other parts because close tolerances must be maintained to get top efficiency and economy.



MAKE THOSE MINOR DETAILS

Pay Off in Speed and Range

By MAJOR THOMAS H. BONSER, *Flight Data Branch, ATSC, Wright Field*

How fast and how far a plane flies can depend as much upon the so-called secondary considerations of finish and cleanliness as upon performance of the aircraft's major assemblies. To maintain streamline zip in your plane, here are practical tips on aerodynamic efficiency—what cuts it down and what'll build it back up.

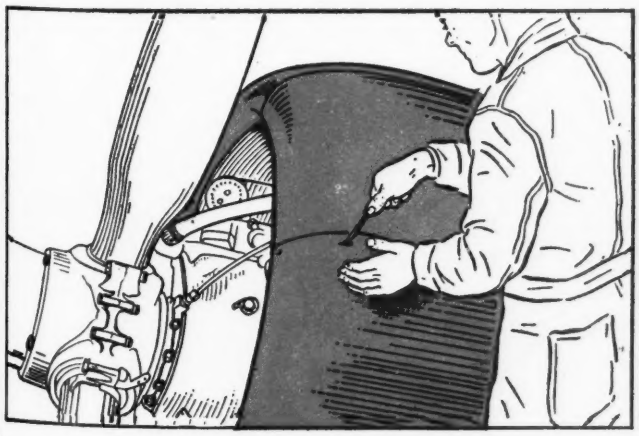
IT IS NOT ENOUGH to tackle and accomplish the more complex maintenance problems if, meanwhile, there are slip-ups on some of the finer points. For many of these little things, when added up, can become serious, with a resultant decrease in aircraft efficiency. Mechanics, in their ardor to complete the big job, may forget to attend the niceties of workmanship which are so much a part of good methods and proper technique. When the future of civil aviation is visualized, the need for master technicians who know the importance of stressing the exacting points of aircraft maintenance can easily be understood.

In the category in question we have aerodynamic maintenance, or the process of keeping airplanes aerodynamically clean—in other words, the elimination of bumps, projections, dents, and roughness of finish so as to present the least possible resistance or drag. An airplane that is not aerodynamically efficient may be compared to a ship loaded down with barnacles.

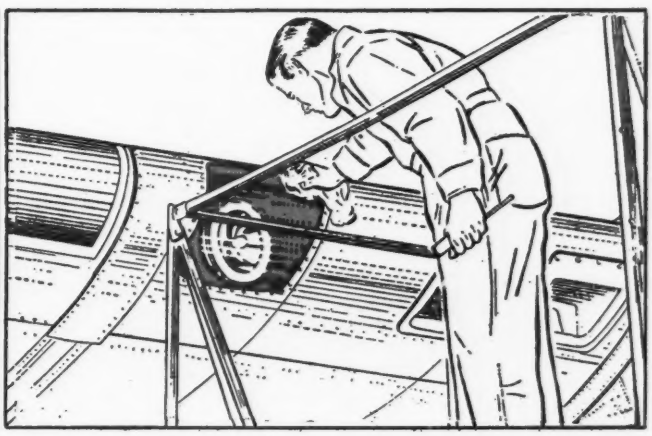
Realizing the importance of this phase of maintenance, the ATSC at Wright Field accented its importance early in the war. Indeed, conscientious adherence to these principles probably was the deciding factor in many air battles. High speed aircraft must be smooth aerodynamically to be fully efficient, and this maintenance provided a superiority when most needed in combat. Of course, the same type of efficiency would be important in commercial aircraft operation. Realizing that the German V-2 rocket bomb travels at speeds exceeding 3,000 mph. and that our own jet propelled fighter aircraft can travel from Dayton to New York in approximately one hour, we can be assured that the basic principles of these speedsters will be adopted to our future commercial aircraft—all of which will amplify the importance of this phase of maintenance.

The amount of power necessary to propel an airplane varies as the cube of its indicated air speed. Therefore, when an airplane's speed is doubled its power must be multiplied eight times. Likewise, it can easily be understood that any drag would become eight times greater in an airplane whose speed has been doubled.

When an airplane becomes aerodynamically rough, then fuel, speed, and range are sacrificed. Tests on combat airplanes which had been allowed to deteriorate in aerodynamic cleanliness and then were gone over with painstaking attention to smoothness have shown high speed increases of from 9 to 15 mph. in the 300 to 400 mph. range. The advantages that can be gained by such improvement are enormous. For example, if there is an increase of 9 mph. and the airplane has a 10 hr. fuel range, it can fly an addi-



Remove Dzus fasteners with a screwdriver.



See that landing light Plexiglas fits properly.

Inspect cowl flaps for bends and scratches, then check alignment.

Always use proper technique and tools designed for specific job.

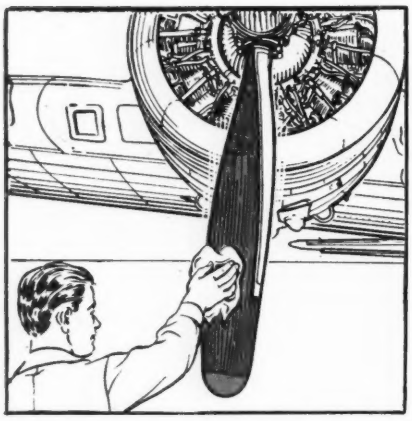
Spot putty can be used to smooth surface irregularities.

tional 90 mi. without using more fuel.

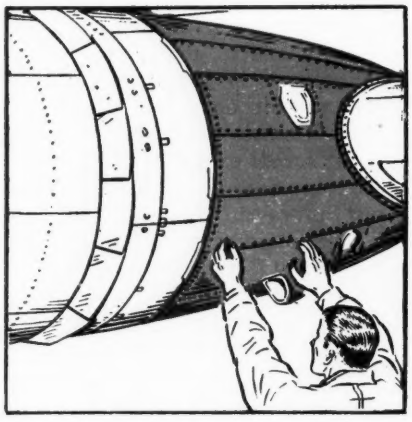
In the war, this 90 mi. often meant the difference between pilots returning to their bases or being listed as missing. And in peacetime operations of transport aircraft, the advantages of such gains in range and speed are likewise significant.

A new airplane affords the top aerodynamic efficiency of the specific design. However, after the craft has been in use, a combination of one or more conditions may develop. Singly, these conditions may not be too important, but when a combination of them exists, their effects can be serious. We mean such considerations as—

1. Cowling, panels, fillets, fairings, inspection doors, leading edges (if detachable) poorly fitted and out of shape.
2. Use of external instead of flush skin patches.
3. Paint or dope scratched and chipped.
4. Dirty external surfaces, old oil smears, etc.
5. Dents in leading edges of wings, in stabilizers, or in cowling.
6. Identification lettering and insignia not properly applied.
7. Cowling access door fasteners and screws missing.
8. Main landing gear doors and fairings not fully closing or not flush with surface.
9. Cabin doors and canopies sprung, or not fitted properly.
10. Stabilizer and aileron cut-outs not providing a continuous airflow



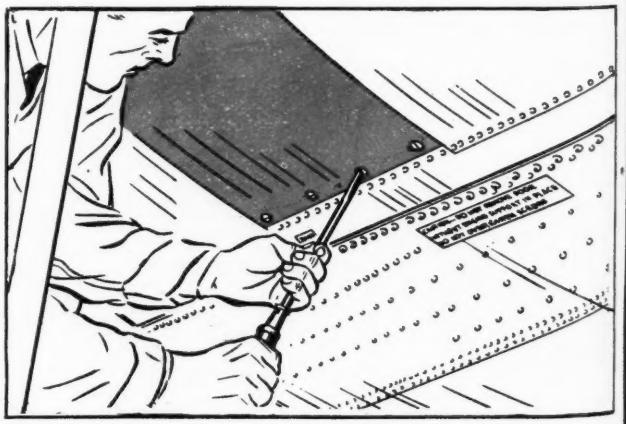
Remove grease from propellers and polish surface, watching carefully for scratches.



Inspect nacelles for dents and sheared rivets. The latter should be replaced.

Projections and poor fittings are frequently found at connecting joints.

Fillets should be inspected for fit and contour.



Check fit and tightness of inspection doors.

in line with the ailerons and elevators.

11. Poorly fitted tabs, leaving rough joints or misalignment.

12. Wing top surface scratched by walking on them with nailed shoes or dented from walking on "no-step" areas.

13. Face of the propeller blades rough and leading edges nicked.

And now let us outline some "Don'ts" which personnel should observe in efficient aerodynamic maintenance:

1. Don't use bolts or rivets with projecting heads in place of flush-type fastenings.

2. Don't be lax about keeping the airplane clean.

3. Don't place ladders or stands against airplane surfaces. Distortion will inevitably result.

4. Don't lay cowling and panels on wings. They cause scratching. Moreover, they may blow off, causing them to be knocked out of shape.

5. Don't apply insignia enamel or paint without thoroughly cleaning and smoothing the surface. Painting over an uneven or dirty surface gives a slovenly appearance and appreciably increases skin friction.

6. Don't walk on wings with nailed shoes.

7. Don't lay down cowling panels or fairing with external side down. This practice results in scratches which cause skin friction.

8. Don't step on "no-step" areas.

9. Don't toss any tool to another man when working. He may miss it or drop it on the surface of the plane causing a dent or a hole.

Bear in mind the importance of the elimination of all irregularities exposed to the airstream, especially those that are located in the forward portion of any streamlined surface—because any deformations in these areas not only increase drag but are also contributing causes of aileron and tail flutter. The entire airplane should be inspected carefully to detect and correct such defects. Methods of correction in most cases are obvious, but in others a considerable degree of ingenuity may be necessary.

The following methods are suggested for elimination of the undesirable conditions previously noted:

1. Keep airplane clean, both externally and internally. The accumulation of grease or any soft film causes dust, sand, or other foreign matter, to be picked up, resulting in a very rough aerodynamic surface. Internal dirt, while it does not change the shape of the airplane, adds weight, especially if it accumulates moisture. The effect of this weight on performance will be readily evident.

2. Remove scratched, chipped, or rough paint, making sure that the surface to be repainted is absolutely clean and that before repainting, edges of the old paint have been feathered or smoothed with fine sandpaper, pumice, or some other type of fine abrasive. Always wash off dust before painting.

3. Poorly fitted cowling, fairing, fillets, and inspection doors should be carefully reshaped and refitted so that they will make a perfect joint. Straightening bent-up edges caused by any prying during removal.

4. Replace outside patches with flush ones, using countersunk rivets, if possible.

5. Replace loose fasteners. An empty hole not only causes drag but the loose material may vibrate, inducing failure and loss of the cowling; or the cowling vibration may have an aerodynamic reaction causing flutter as well as drag.

6. Smooth out all accessible dents in leading edges.

7. Using smooth patches, cover all holes for equipment which has been removed.

8. Rework and refit all landing gear and cabin doors and fairings to provide as smooth a fit as possible.

9. Straighten trailing edges, aileron and elevator cut-outs, etc.

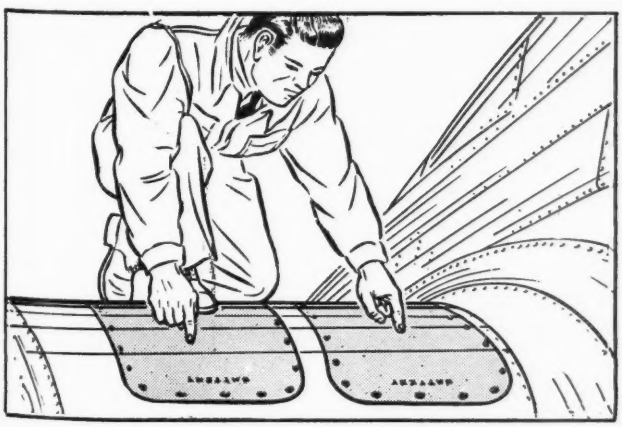
10. Remove all unused or unnecessary projecting insulators, bolts, or rivets which can be replaced with flush types.

11. Clean up nicked or roughened propellers. This work should be accomplished in accordance with CAA regulations to prevent the possibility of ending up with a weakened blade or an out-of-balance condition.

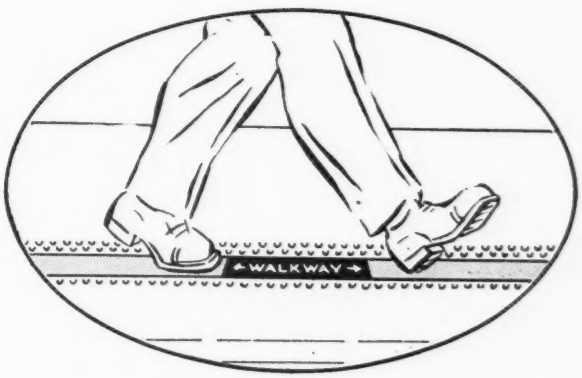
12. Apply Vitraloid glazing lacquer, spot putty, or the equivalent, to leading edge and wing tip joint gaps or any other depressions which can't be smoothed to create a clean, flush surface. Since these materials are not permanent, periodic inspection for cracking and flaking is necessary. Deterioration of these materials occurs through temperature changes as well as from working of the surfaces, hence renew application when necessary.

Camouflage paint on military aircraft proved beneficial from an anti-corrosion standpoint, since washing of the military planes was often impossible under combat conditions. However, external paint, applied carelessly or allowed to deteriorate, results in a rough finish, very undesirable aerodynamically. A rough surface can be smoothed by light water sanding with waterproof abrasive paper, grit No. 320. Sandpaper scratches are removable by rubbing the surface with pads of cheesecloth or other absorbent material which has been soaked in water and dipped in powdered pumice No. FFF.

Proper pumice action will pick up the color of the paint, after which the pumice should be removed with wet rags. Water alone will not remove it. The use of wax as a smoothing agent or filler is not recommended because it tends to remain soft and pick up dust in warm climates, creating a very rough surface. Although exteriors are not generally painted on metal commercial aircraft, insignia and numerals are used, in which case it would be a good idea to bear the foregoing information in mind.

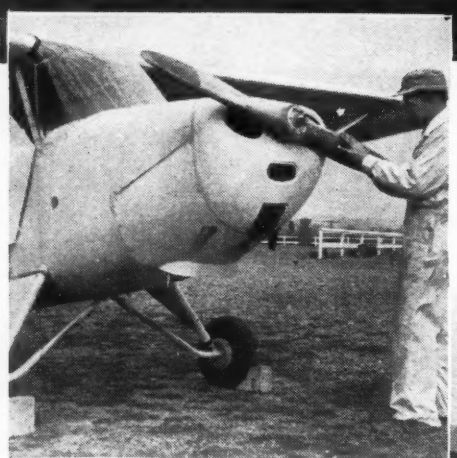


Fit of doors in leading edge is very important.



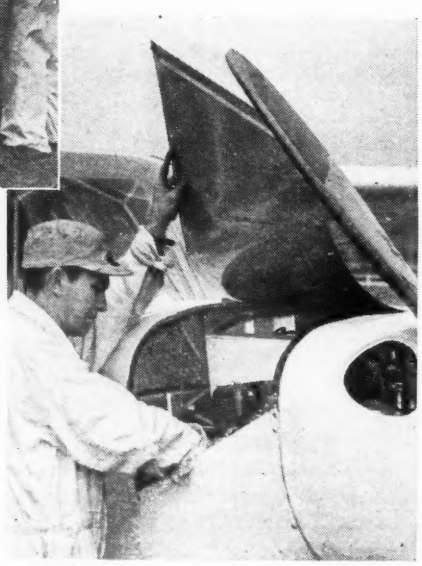
Wing walkways are installed to save thin surfaces from damage. They should be used exclusively.

Check the Plane AND YOU Check the Costs



Correct check procedure is graphically illustrated by the accompanying pictures snapped at Otto Aviation's Blairstown, N. J., base as Chief Mechanic John Rothbauer inspected a new Aeronca Champion. First inspection step is to hang check form in a convenient place, as shown. Next manually check to assure that switch is "OFF", then shut off fuel. (Aviation Staff photos)

Propeller is inspected for blemishes, looseness on hub, and security of hub bolts.



Engine and parts forward of firewall are checked for oil leaks, tightness of fastenings, and condition of wiring. Exhaust and intake manifolds should be inspected for leaks, also bolts and nuts manually tested for looseness.

WITH THE ALMOST CERTAIN issuing of CAR permitting pilots who have private licenses to inspect their own planes, the subject of daily and pre-flight inspections has become of great importance to many whom it did not previously concern.

Though the major inspection at 100 hr. calls for dismantling a considerable part of both engine and airplane, with the object of replacing any parts which may show signs of serious wear, these replacements may be minimized by careful daily or pre-flight inspections. Because these inspections are mainly preventive and do not call for the same amount of mechanical experience needed for overhaul, it is entirely feasible for the operation to be performed by one who, though not a licensed mechanic, nevertheless has a clear

knowledge of the construction and operation of both aircraft and engine.

Because daily and pre-flight inspections are also for the purpose of determining the airworthiness of the airplane—though minor adjustments may be made—much care should be taken to insure that no detail has been overlooked, nor any adjustment left unchecked. In no case should any inspection be made before checking to see that the ignition switch is in "OFF" position and fuel turned off.

Clean windshield and inspect for scratches and weather tightness of rubber sealing strips.

Propeller Inspection

Commencing at the propeller, grasp one blade and shake fore and aft, to discover any looseness. Remember, while doing this, that the blade is thin and may be bent by too great force. On wooden props, the surface should be checked for scars or scratches, or for scratches or cracks in the case of metal blades. Wood blades may be retouched with a thin coat of varnish over the blemish, but metal blades call for more extensive treatment. Very light scratches may be rubbed out with fine carborundum cloth, followed by a final smoothing of the surface by polishing with crocus cloth. Any deep scratches or cracks require removal of the propeller. Small cracks in a woodblade's tipping are permissible. (Also see page 174, Aug. 1944 AVIATION.)

Hub retaining lock or bolts, nuts, and lockwires must be carefully inspected for looseness. In this operation and in all other cases where bolts or pins are being checked, use one hand to pull on each end to discover if the bolt is broken.

All types of propellers should be checked for track. This is accomplished by using a pointer, mounted on any convenient object and placed in contact with one blade tip in its lowest position. The other blades are then turned downward in turn and any discrepancy in their position is noted. In the case of medium size wood props, this may be $\frac{1}{8}$ in. without causing trouble, but metal blades are usually held to a tolerance of $\frac{1}{16}$ in.

Inspection Under Cowling

Check manually all nuts, locknuts, and other fastenings around the engine, giving special attention to engine mount nuts and bolts if in this section.

Note any signs of oil leakage from crankcase, rocker box covers, pipe connections, or gasketted connections. Slight oiliness may merely be noted for later preventive measures at the 100-hr. inspection, but any signs of steady leaking should be given immediate attention.

Primer and oil lines should be checked for leakage, as should all hose connections. Hose which has become soft enough to be chipped by a finger nail, or which shows signs of cracks, should be replaced as soon as possible. Hose clamps may be checked occasionally to make certain that they have not become loosened.

Intake and exhaust pipe connections must be examined for leaks and cracks. Nuts or bolts holding these parts are especially important, because air leaks into the intake manifold cause lean mixture and an overheated engine, while there is always the danger of carbon monoxide poisoning when exhaust pipe leaks are present.

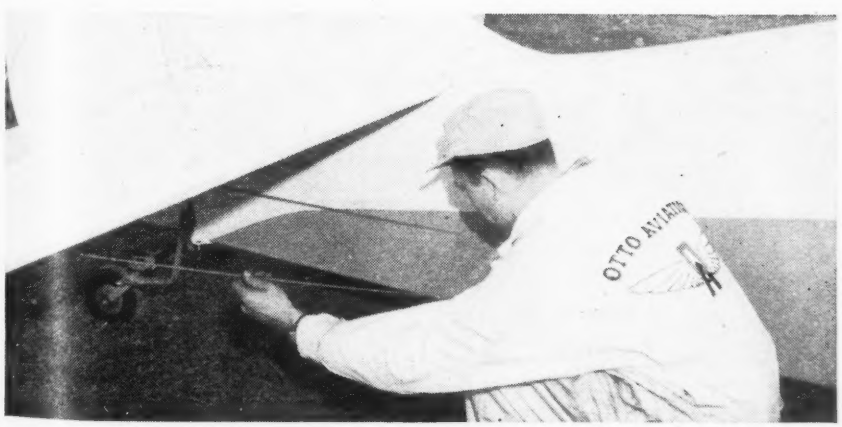
Sparkplugs should be checked for tightness of shielding; or, if unshielded, wiring should be inspected for cracks or contact with metal parts of the engine. All wiring which passes through firewall should be checked at that point for wear or chafing.

Speed ring, front cowling, and other covering parts require occasional checking for tightness of attachments. Do not rely upon visual inspection, but shake each part with one hand. Where plates overlap, looseness is often shown by wear between the sheets.

Have an assistant in cockpit work throttle controls and watch the action at the throttle, to see if full travel is present. Then while holding carburetor throttle lever, have the assistant move cockpit lever to discover any lost motion. Repeat this with all other controls between cockpit and this com-

By HARVEY A. SENIOR, *Flight & Service Inspector, Vought Div., United Aircraft*

Many dollars in subsequent repairs can be saved if personal plane owners exercise care in their daily and pre-flight inspections. The practical methods detailed here cover this work on both plane and engine.



Brace wires require checking for tautness and security of end fittings and attachments to frame. Inspect entire outside of fabric, both for bruises and condition of finish. With assistant holding stick, shake tail control surfaces to detect slackness in connections.

partment. All slack should be taken up before flying.

Check all drains to see that they are clear and that they discharge away from parts of the plane.

Drain, or remove and clean, the bowl of fuel strainer.

Connections through firewall should be checked manually for tightness, and all openings should be provided with grommets to prevent engine gases from penetrating into cockpit.

Landing Gear Inspection

Taking each side separately, check all bolts and fastenings. The fact that all safety wires and cotter pins are in place does not always indicate a safe condition, so check all bolts for wear or breakage by having an assistant shake the wing so as to change the stress on the fastenings. By holding each bolt head in turn, worn or broken bolts can be located with certainty.

Tires should be checked for correct pressure, also check their surfaces carefully to locate nails, cuts, or bad flat places. Rock all wheels with the foot to determine tightness of bearings.

In the case of hydraulically operated landing gear, jack up front end of plane and operate through several complete cycles, building up slightly more than working pressure to locate possible future leaks. If unit is of shockcord type, inspect condition of cords and look for looseness of fastenings. Look out for evidence of bent struts, caused by rough landings.

Wings, Control Surfaces, Fuselage And Cabin Inspection

While on the ground, inspect surface of fuselage for stone bruises on under side. Clean windshield and inspect surface for scratches. Inspect rubber or other molding joining windshield to fuselage.

Remove inspection covers and check tightness of aileron controls by having an assistant shake stick rapidly while aileron is held. Note particularly tightness of hinges. Shake endwise to locate hinge end wear. Repeat test on rudder and elevators. On elevators have assistant hold one side while other is shaken up and down, to determine security of attachment to shaft. Attempt to shake tabs to locate any looseness in attachment or controls.

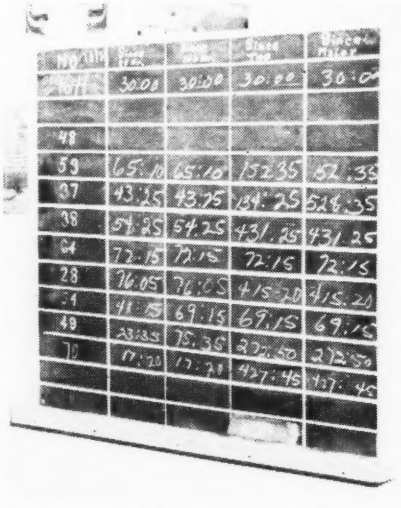
Check leading and trailing edges of wings for damage, if plane has been flown through hail or under icing conditions. Look for fabric cracks and loose joint tape. Have assistant shake wings while attachment bolts are manually tested for wear and breakage.

All exterior and interior cable shauld be checked for tightness, and terminal connections should be inspected. Wipe

After removing inspection plates, check controls for play; shake ailerons, holding finger on hinges to feel for wear.

all accessible cables with a piece of rag to discover any frayed places, particularly near pulleys and fairleads. Wipe all oil from cables, since it collects dust, which causes considerably more wear than when cable is dry. If operator has not inspected this plane before, all control levers should be moved through their extreme range, to check clearance with other parts. In this case, flaps, if present, should be worked through two or three complete cycles.

Inside the cabin, use a flashlight to check bottom connections to fuel tanks. See that there are no dry stains which would indicate slow leaks. If possible, inspect pads between tank and supports. Still using flashlight, check all wires, etc., which pass through firewall. Then check any control wires which have not already been inspected.



Operators should keep track of inspections and top and major overhauls, by using a board like the above. Left hand column denotes last two figures of NC number of plane. Other spaces note time since 25-hr., 100-hr., top overhaul, and major overhaul, respectively. Permitted 10-hr. leeway from exact periods accounts for variations in recorded times. Time for each plane is entered in individual engine and aircraft log books.

Check door lock action, both for security and to insure against vibration. Note if safety wire is in all hinge pins.

Where safety belt is fastened to seat, check both security of seat and condition of belt.

Engine Warm Up

After checking fuel and oil, place chocks under wheels, start engine, and run it to warm up. While this is in process, check operation of those instruments which depend upon the engine for their working. Watch oil pressure gage, oil temperature, and tachometer. See that airspeed indicator—if there is no wind—registers zero. If any variation from zero is shown, make a note of amount in log. Correct knowledge of airspeed is essential to safe flying, more particularly in planes flown at low altitudes.

With stick *full back*, run up engine rpm. Watch oil pressure temperature and instrument gages, cylinderhead temperature, and manifold pressure (if gage is used). Change engine speed several times to check action of these instruments, for their correct indications have much to do with flight safety. Check rpm. on each magneto in turn; speed on one should not drop more than 100 rpm. below that when two magnetos are used.

Test brakes and note if both operate with equal resistance. Soft or spongy action usually indicates either need of adjustment on cable-actuated brakes or bleeding of hydraulic system.

Where there are duel controls, each control system must be tested in turn, unless there is no reason for expecting that the second set will be used, though it is a good plan to make an occasional clearance check to insure that nothing has been dropped and jammed into the moving parts.

The battery does not usually require more inspection than that given at regular battery servicing periods, but the compartment should be carefully gone over for evidences of spilled acid and loose connections.

At altitudes usually flown by small aircraft, electric generators do not require attention between overhaul periods, though connections should be checked frequently, especially if the voltammeter does not give usual indications.

It will be understood, of course, that all the points of this inspection need not and should not be made daily. All details mentioned can be covered, some at one time and others at another, so that the entire plane and engine may be *preventively inspected* to minimize unsuspected wear and deterioration, which otherwise might add an appreciable amount to the overhaul bill.

ATSC Maintenance Never Halts

DESPITE ITS RECONVERSION

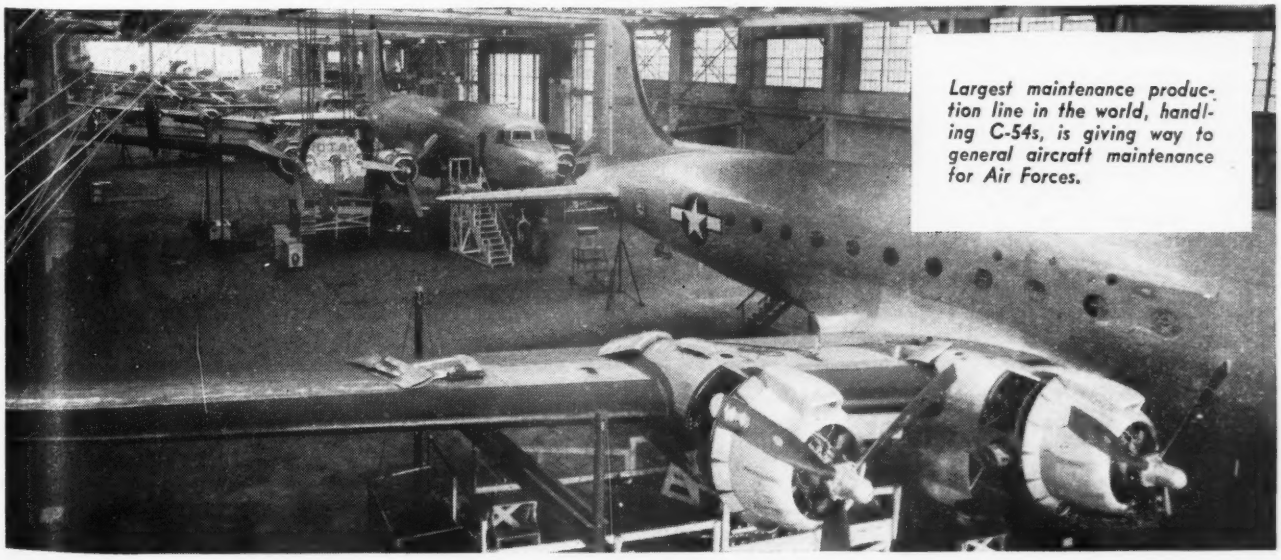
With no pretense of being anything but good soldiers, Middletown ATSC men are taking part in a billion dollar reconversion job as a "sideline" to their real task of maintaining AAF aircraft as the world's most efficiently serviced military planes.

THE ATSC is at present under a considerable disadvantage, as compared to civilian businesses, since it cannot shut down for reconversion, but instead must continue with current work as if nothing unusual were happening, while making drastic changes affecting every department of its organization.

Typical example of how this knotty problem is being solved is being demonstrated at Olmstead Field, Middletown, Pa., where, under Lt. Col. C. W. Draper, ATSC, the largest engine and aircraft maintenance base in the world is conducting these parallel operations without permitting either one to interfere with the efficient working of the other.

Briefly, there are three separate phases into which the changeover can be divided: First, provision must be made for service and overhaul of all types of AAF aircraft in place of the former highly specialized Douglas C-54 operation; second, smaller peacetime volume of work requires reducing or combining many departments with as little disruption of routine work as possible; and third, an enormous amount of heavy equipment must be moved, in some instances for a distance of several miles.

Simultaneous preparation of planes permits use of large number of workers in cases such as this, where approaching deadline for delivery demands group completion.



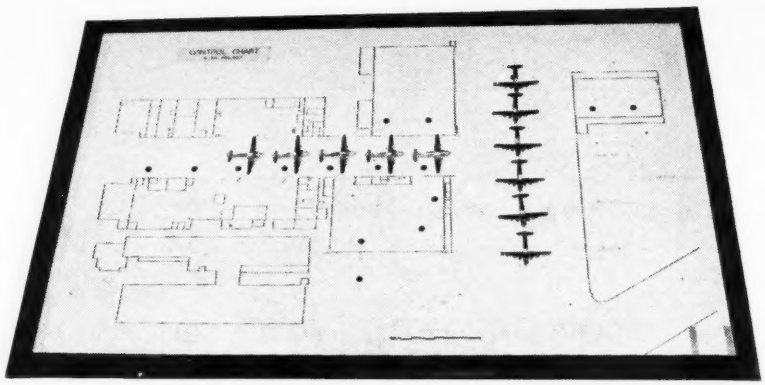
Largest maintenance production line in the world, handling C-54s, is giving way to general aircraft maintenance for Air Forces.

Conversion from specialized to general servicing involved the handling of all lighter units now in use, most of which will call for occasional group overhauls rather than a continuous operation. Because of this condition, it was decided to handle these aircraft on the floor as units, rather than on a production line basis which would require continual changing.

On the other hand, overhaul and servicing of big bombers would have to be carried on by the same assembly line methods used for the C-54's during wartime. Because the two types of operation cannot very well be mixed, the hangar previously used for C-54 final inspection has been taken over for smaller planes, chiefly single seaters, of which this base will handle a large number. This department is now busy reconditioning many types of planes for the U. S. Army Air Forces. And it is having no serious trouble in meeting its deadline, in spite of the "orderly disruption" taking place all around it.

Combination or reduction of departments posed a more difficult problem—one which has been met successfully by interrupting the work of but one department at a time. This method permits the balance of the work to continue as usual, and the accumulation of interrupted work orders is confined to the department undergoing change, preventing an unwieldy backlog which would eventually overwhelm the capacity of the reduced organization. Under this single-department change system, the maximum work thus on hand usually amounts to about three days output, which can be absorbed without too great effort after the shop in question resumes operation.

Through a skilled-personnel reduction to 40 percent of that used during wartime operation, condensation of several departments into one has not caused an overcrowding problem. An example of this is the landing gear department, which now has absorbed both wheel and brake repair. The space formerly used for landing gear work alone will now accommodate all three lines without interference. Another consolidation has brought together into one department the operations formerly conducted in three—propeller repairs, radiators, and fuel tanks.



Desk-size plan of Douglas C-54 assembly line used for keeping track of work progress. Numbered plane models are moved from station to station (black dots) as reports come in from shop.

Another method of using existing plant equipment economically, in spite of reduced output requirements, is that in use in the sheet metal shop, which now uses its excess facilities for making aircraft radio brackets and kits, which would otherwise be purchased.

Partial operation of a department in process of being moved to a new location is exemplified in the wings unit, which is gradually giving place to the electrical consolidation. Where as formerly each branch of electrical work was in a department of its own, the new shop will undertake all electrical work, except radio, which is too highly specialized to be handled by a general repair and overhaul center.

The wings department is slowly withdrawing to the smaller space now allotted, each move providing more space for the electrical workers who displace it. Thus, work on wings is continuing without interruption, though the balance of the floor is under conversion to the new department. Finally, the wings and sheet metal departments will be combined without serious interruption of work.

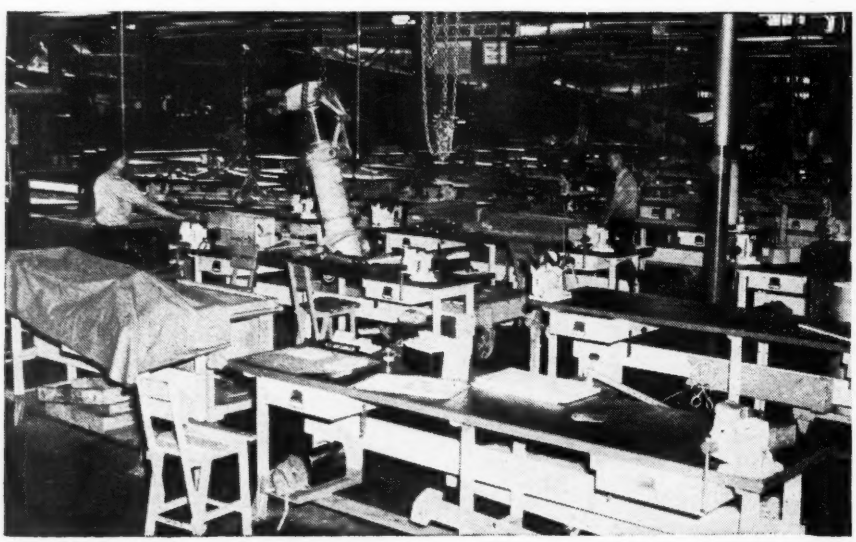
Two Laboratories Combine

Another combination permitted by reduction of output requirements is that of the camera and bombsight laboratories, which both operate in space that was formerly devoted entirely to photographic equipment. This change was comparatively free from complications, the camera division continuing to operate while the bombsight apparatus was moved into space originally used by camera service.

With cessation of hostilities, the armament division grew smaller and was able to operate in only a part of its original space, thus providing room for other sections being displaced from their former locations.

Engine overhaul—during wartime, the world's largest, turning out 1,600 twin-row power plants per month—formerly occupied a large exhibition building in Harrisburg, ten miles away. This operation is now being removed to Olmstead Field, and several extensive changes in floor arrangement have been necessary to provide the required space.

It was decided that the former shop-equipment department would provide a space sufficiently large for engine overhaul, but then what would be done with shop equipments? To make room for this department in its reduced condition, it was necessary to move the electrical shops to new locations. Net result is that engine overhaul is now where maintenance equipment used to



Former exclusively landing gear shop now handles wheels and brakes in addition. Douglas C-54 landing gear unit is seen in left center. Weighing 1,800 lb., it must be hoisted.

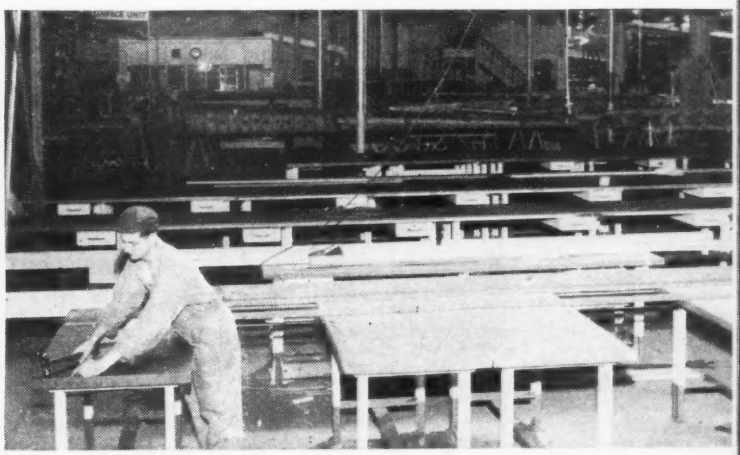
be, while maintenance equipment is where electrical fought the Axis a year ago. Electrical has moved in with wings, which shrank but stayed put. And wings is now preparing to consolidate with sheet metal, which has gone into radio kits as a side line.

While this was in process, engines were still overhauled, shop equipment had efficient maintenance, electrical accessories received servicing, wings were ready when required, and sheet metal started an extra-curricular manufacturing project!

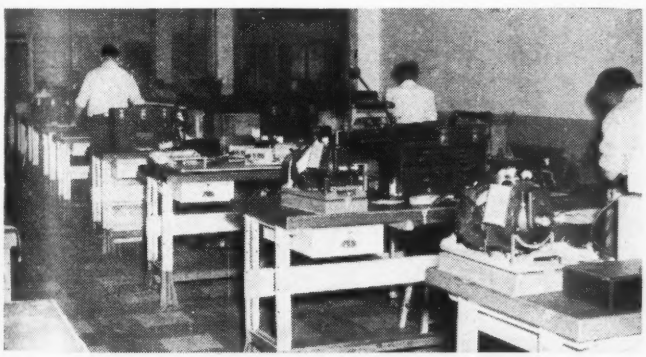
Olmstead Field, in spite of these reductions in space and personnel, is the service and overhaul center for more territory than before these changes. Whereas seven states including Long Island, plus the District of Columbia, were formerly covered, there have now been added to this area the states of Kentucky, Michigan, Indiana, and Ohio. The heaviest part of future work will be in overhauling combat planes, but all AAF aircraft in the territory will also be brought here. In addition, planes of the National Guard, CAB, and Officers Reserve in the District will use the Field's facilities and personnel for overhaul.

Without posing as efficiency experts or industrial wizards, ATSC men are quietly doing a reconversion job involving billions of dollars—with reduced personnel and reduced appropriations. And while they are thus engaged in this "side line", the same men are carrying on with thier regular job of keeping the USAAF the most efficiently serviced group of military aircraft in existence.

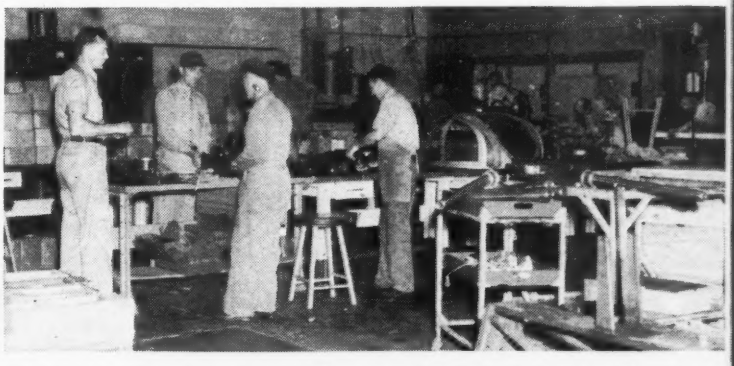
Sheet metal shop builds radio brackets and kits to take up slack caused by change from war to peace operation. This shop and wing department will eventually be merged.



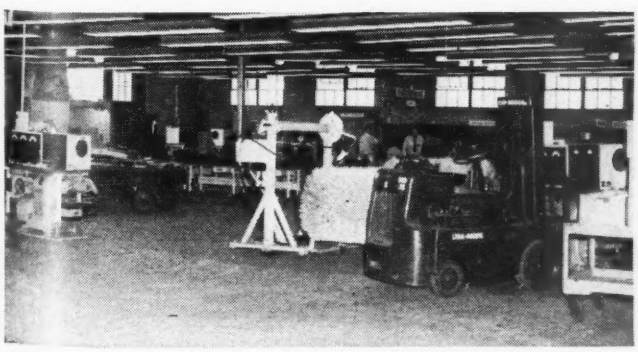
Wing shop is receded (background) as new benches are built for electrical department, which is taking over most of floor. Change does not affect operation of wing department, which carries on.



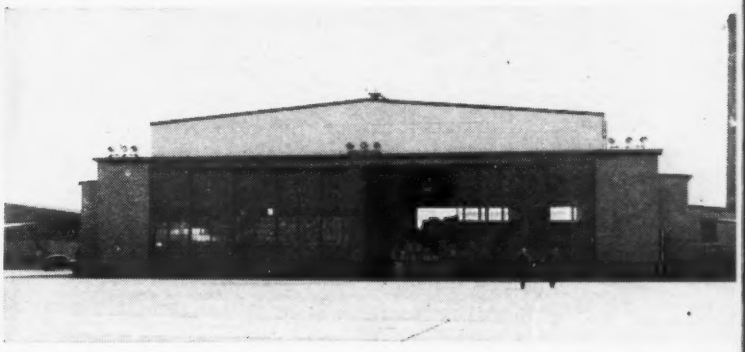
When camera department (right) found itself with less cameras to service, bombsight testing and repair moved into left hand side of shop, formerly also used for cameras.



Reduced armaments mean reduced armament department, which withdrew into considerably smaller space than was employed in days when planes wore out more guns than engines.



Where formerly electrical accessories were carefully calibrated, plant maintenance machinery is now serviced. Drum-like object (center) is sweeper brush.



Formerly a flight test hangar housing C-54's of ATC, this building is now used for warehousing shop supplies. Parts and accessories for shipment are still kept in wartime warehouses.

Maintenance System Mainsprings

PICK-UP LINE'S EFFICIENCY

By EDWARD E. THORP, *Assistant Editor, "Aviation"*

Hundred-mile-per-hour hedge hopping for thousands of miles every day calls for highly specialized maintenance backed up by this simple but effectively up-to-the-minute parts time checking system installed by Supervisor E. D. Musser.

THERE IS PROBABLY no branch of civil aviation—except crop dusting—which calls for such continuous supervision of maintenance than does the pick-up airline.

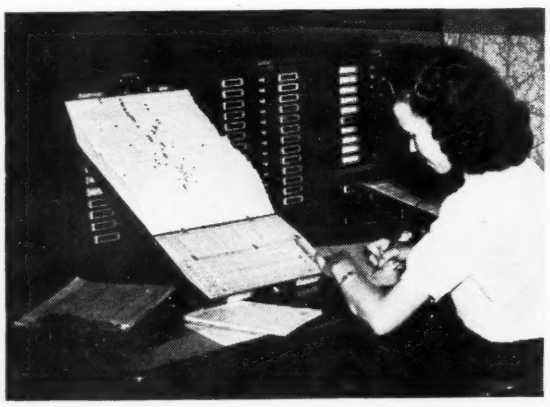
Speeds are not high, compared to those of passenger carrying lines, but the ever recurring mail and package pick-up operation imposes far greater strain on equipment than does the longer and faster, but comparatively smooth flight of the trunk airliner.

Possessing less than a dozen planes, All American Aviation cannot economically employ an office force such as would be required if usual airline methods were used for keeping track of overhaul time. It is necessary to have a system whereby not over two extra people are continuously busy keeping records.

Basis of the system is the Parts Time Tablet. This is a standard card index, provided with overlapping hinged cards, with one drawer for each plane. Top card is the master record of the plane's flight time, the bottom edge of the card being marked off in a scale of hours. After each flight a marker is moved along the hours scale to correspond to the total time flown to date.

Directly under this master card are hinged a number of others, one for each replaceable part or reparable assembly. The lower edge of each card is marked off in hours exactly as is the top one. On this hours-scale is clipped a marker at the point which corresponds to the remaining time the part can be used before requiring overhaul. When the marker on the plane flight hours card comes directly above that on an accessory card, it is an indication that the part is to be replaced and the old one overhauled.

By this means the time status of every part can be observed in a few seconds, without removing a single card from the drawer.



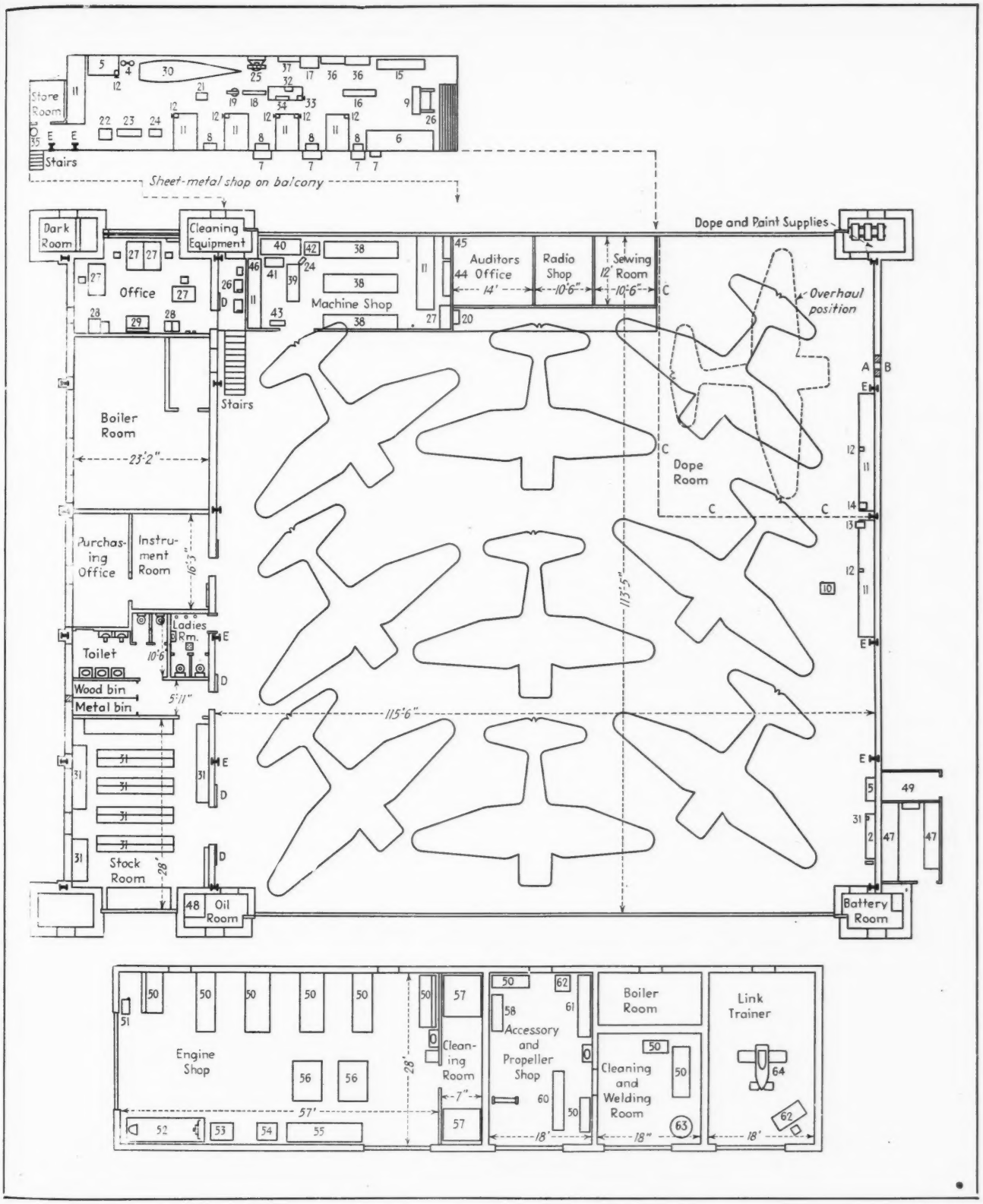
Parts time tablet for each plane has card for each part and one for flight time at top. Lower edge marker on top card is moved daily towards right as time accumulates. Parts cards carry markers corresponding to overhaul periods. When flight time marker lines up with any part marker, that part is replaced for overhaul. System gives instant visual check of status of all parts on every plane and warns of impending overhauls in time to allocate necessary work.

Because even an adequate shop staff can find itself swamped if no means is provided to notify it regarding future work, a Parts Time Report is made up every day and sent to all foremen, and to the chief inspector, dispatcher, and superintendent of maintenance. This form lists all parts which are within 10% of the end of an overhaul period. From it the foreman can tell approximately when more work will be coming in; the dispatcher knows what plane will be out of service; the chief inspector is able to schedule his work more efficiently; and the superintendent knows fairly closely just how busy his shops will be for some time ahead.

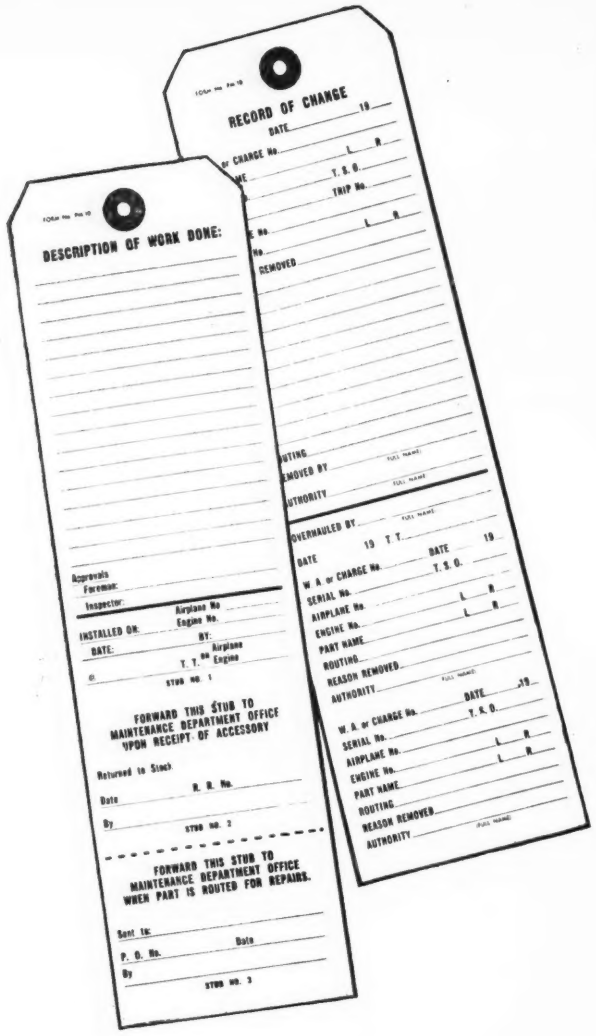
To enable the stores to be kept supplied, but not overstocked, and to provide the various overhaul foremen with an index of the parts soon to be required from their departments, the Daily Inventory is filled out and sent in to the office, whence it is distributed to those whom it concerns. With only two columns of figures, and possibly a few remarks, the clerical time required does not interfere with shop supervision.

Shop record of change and overhaul is kept on a tag attached to the part when removed from the plane or engine. This tag carries all particulars, including the reason for removal. On the back is space to be filled in with a description of the work as it progresses.

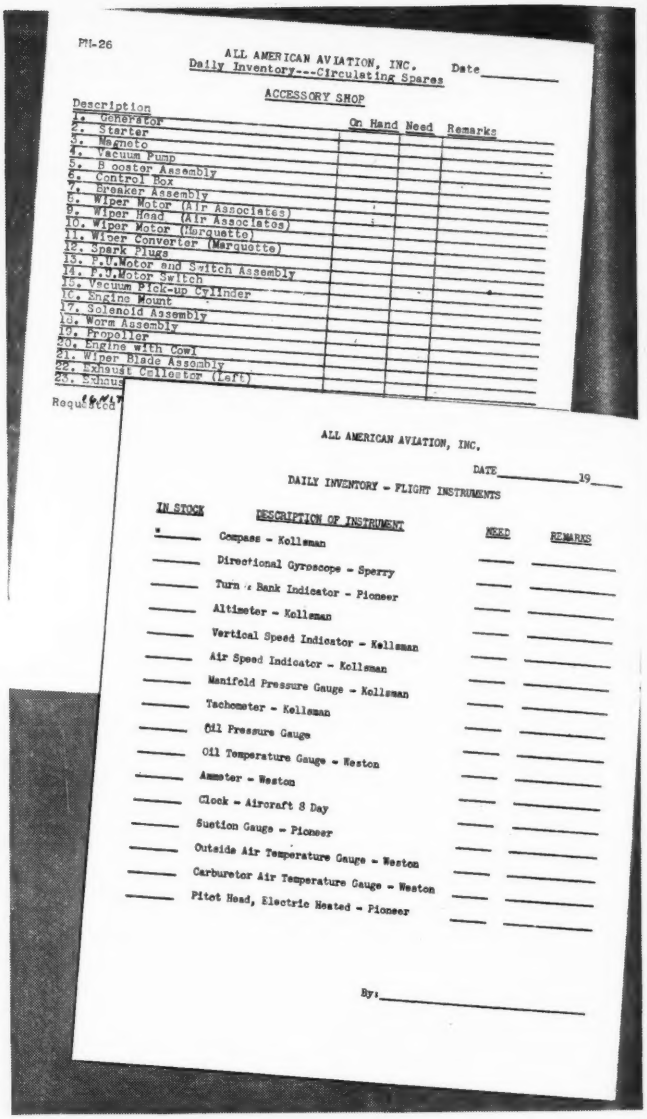
Stubs are removed from the bottom of the tag—first, when the part is completed and sent to the stockroom, and second, when the stockroom sends the part out to be installed, at which time the second stub is stapled to the upper portion, so that the two, together, provide a com-



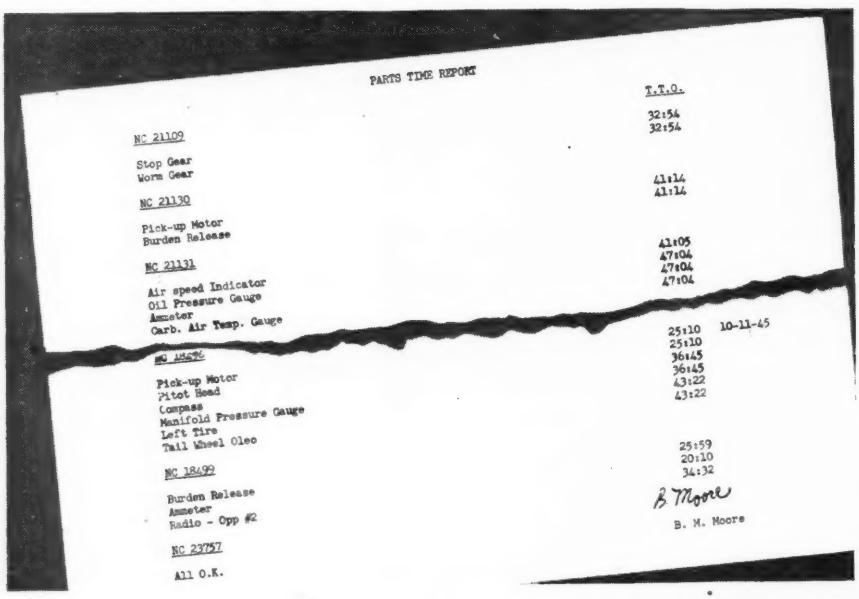
Floor plans of hangar, office and shops of All American Aviation at Allegheny County Airport, Pittsburgh, Pa. Equipment is: (1) anvil, (2) bench, (3) Nu-Typ vise, (4) welding equipment, (5) welding bench, (6) sheet metal layout bench, (7) overhanging rivet bins, (8) tool box stands, (9) squaring shear, (10) bandsaw, (11) work benches, (12) vise, (13) grinder, (14) drill press, (15) 2-ft. bending brake, (16) 36-in. rolls, (17) tool cabinet, (18) bar folder, (19) pneumatic planishing hammer, (20) battery charger, (21) sheet metal shrinker, (22) drill press, (23) 48-in. brake, (24) grinders, (25) engine mockup for parts fitting, (26) 1,000- and 2,000-lb. scales, (27) desks, (28) filing cabinets, (29) table and rack, (30) fuselage for fitting metal bellies, (31) stock bins, (32) beading machine, (33) bevel shear, (34) bench shear, (35) trash container, (36) metal bins, (37) parts bins and lockers, (38) lathes, (39) pick-up gear work bench, (40) stock rack, (41) hydraulic press, (42) drill press, (43) hacksaw, (44) tool cabinet, (45) parts bin, (46) cleaning vat, (47) wash racks, (48) door counterweights, (49) sandblasting unit, (50) benches, (51) grinder and buffer, (52) Magnaflux, (53) cylinder hone, (54) valve grinder, (55) cylinder rack, (56) parts trucks, (57) cleaning vats, (58) Wiedenhofer tester, (59) prop balance stand, (60) prop table, (61) sparkplug overhaul, (62) desks, (63) welding table, and (64) Link trainer.


RECORD OF CHANGE
DESCRIPTION OF WORK DONE:
FORWARD THIS STUB TO MAINTENANCE DEPARTMENT OFFICE UPON RECEIPT OF ACCESSORY
FORWARD THIS STUB TO MAINTENANCE DEPARTMENT OFFICE WHEN PART IS ROUTED FOR REPAIRS.

Record of change tag is attached to each part or engine replaced or removed. Upper portion remains with each item until returned to stock. Tags at bottom are detached and handled according to directions printed on back.



Daily inventory from each department tallies number of assemblies on hand and number required, has space for remarks by foreman.



Parts time reports are made out daily and sent to each department. Time till overhaul of all parts within few days of replacement is given, to enable foremen to plan operation of future work without overloading or slack time.

plete history of the part from the time it is removed for overhaul until it is again placed in service. These tags are kept as records which can be referred to when the part is returned for another overhaul.

Summing up, this system keeps track of flight time and due date of overhaul of every part; notifies foremen and others of impending work, thus preventing overload; keeps track of replacements on hand and required; and provides a concise history of work done by, and done on, every item which passes through the shops. With the exception of a few minutes of each foreman's time used for filling out a short form, all record work is performed by one clerk.

At a time when so many feederlines are being started, a system such as this has many applications, both because of its efficiency and also because its operation does not call for the entire space of a separate office.

TAKE CARE OF THOSE Airplane "Eyes"

By JAMES J. RODGERS and NORMAN HARLAN

The good eyes of the pilot are often handicapped by the dim eyes of his airplane—dusty, scratched, or distorted windshields. Here are proven methods for avoiding that bugbear of many airmen—blind flying in broad daylight.

TO THE AIRMAN ALOFT, visibility depends as much on the state of the windshield as on the weather. A scratched or dirty window is not only a nuisance, it is a menace to the pilot and to any other flyers who may be in the air near him.

Granted, the layman, having grown up with glass as a constituent of so many common things in his life, seldom realizes that the transparent plastic used on aircraft is a very different substance. But more specifically, there even are many persons directly associated with avaition who have merely accepted these materials without stopping to gain a practical knowledge of them. However, for efficient maintenance of these transparents, some pertinent understanding is a requisite, not only for the operator, shopman, and serviceman, but also for the personal aircraft owner and pilot. Accordingly, the aim of this article is to impart practical care-and-repair information which may be of value to all classes of aircraftmen from the flyer to the fixer.

Widespread acceptance of transparent plastics has created new problems in maintenance and repair. This material has many advantages over glass, for it is light in weight, easy to fabricate, and lends itself to rather simple repair procedure. But plastics lack the surface hardness of glass and require great care when servicing to prevent scratching.

Three main types are employed in the construction of transparent enclosures for aircraft: Acrylic, laminated acrylic, and cellulose acetate base plastics. The acrylic plastics are manufactured under the trade names Lucite, Plexiglas, and Perspex. Laminated acrylic plastics are made from acrylic plastics bonded by a vinyl resin interlayer but are not characterized by specific trade names. Cellulose acetate base plastics are manufactured under the commercial names Fibestos, Lumarith, Plastacele, and Nixonite.

Acrylic plastics, commonly used for transparent enclosures on both commercial and personal aircraft, will be specifically discussed in this article.

Operators should exercise care in properly identifying the material to be repaired or replaced. The following methods are suggested:

Burning—Both acrylic and cellulose acetate base plastics have characteristic odors. Ignite a sample, allow it to burn for several seconds, blow out the flame, and immediately check the odor with that of a known sample.

Visual Inspection—View the light transmitted through the edge of the piece. Acrylic plastics appear colorless while celulose acetate is relatively dark, and may have a slight bluish cast.

Flexing—Acrylic plastics are more rigid than cellulose acetate base materials, and will bend less readily. When making this comparison be sure to use a known piece of equal size and thickness as the unknown.

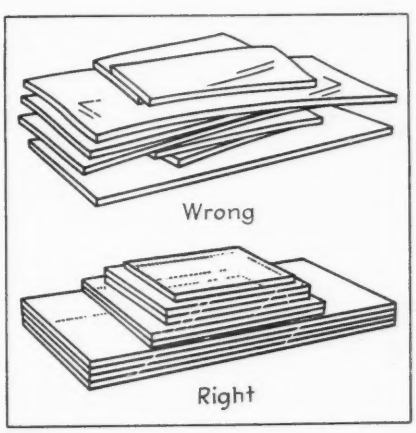


Fig. 1. Plastic sheets should be stored in low stacks with smallest pieces on top to prevent overhang, which causes bending.

Airport operators should exercise certain precautions when storing acrylic plastic, which is thermoplastic and will soften when heated sufficiently. Keep the sheets away from hot water and steam pipes. Although sun light is not harmful, masked sheets should be kept out of direct sunlight, for the rays may accelerate deterioration of the masking paper adhesive, which may cling to the plastic, making its removal difficult. Store the sheets in a cool, dry location, away from solvent fumes, such as may exist near paint, spray, and paint storage areas. Keep the sheets flat in piles not over 18 in. high, in special vertical racks, or in original packing cases. Place small sheets on larger ones to avoid unsupported overhang (see Fig. 1).

If plastic sheets become bowed due

to improper storage, remove masking paper, heat to forming temperature, place on a flat surface protected by a layer of soft flannel, and allow to cool. In storing sections already formed, support them rigidly, to insure retention of their original shape. Simple frames or supports are desirable to relieve strain or unusual pressure on curved parts. Avoid vertical nesting unless storage is in specially designed racks. Always cover the parts with cloth or soft paper to protect from dust. Protect formed parts from temperatures higher than 49 deg. C. (120 F.), which might tend to make them lose their shape.

The masking paper is tough enough to protect the material from minor scratches, but care must be exercised to avoid sliding of sheets against one another or across rough or dirty tables. If it is necessary to remove masking paper during fabrication, the surface should be remasked as soon as possible. Either replace the original or apply new paper, using approved adhesives, such as smooth starch paste, gelatin adhesive, or a rubber type adhesive. If the masking paper hardens to the surface through long or improper storage, hence is difficult to remove, moisten the paper with kerosene or hexane. This will loosen the adhesive. Wash the sheet with soap and water and rinse with distilled water before attempting forming operation.

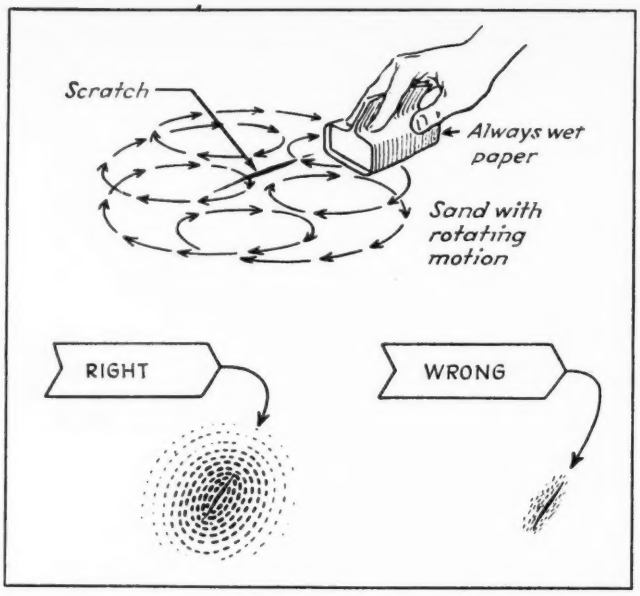


Fig. 2. Sanding isn't advisable unless deep scratches necessitate it. Use smooth rubber or wood block with wet, waterproof sandpaper, working with circular spiral motion over wide area to prevent optical distortion. Too much pressure will burn plastic.

Do not use gasoline, benzene, acetone, carbon tetrachloride, fire extinguisher or de-icing fluids, lacquer thinners, or other solvents to remove the masking paper, for they will soften and craze the plastic surface. Formed parts may be protected by spraying a protective coating of "Spraylat". To remove spray-masking from the plastic, peel it off or lift a corner of the film and blow a jet of compressed air under it. Sometimes a paper tab is imbedded in the film to aid lifting.

Cements used for acrylic plastics are solvents which permit the two joining surfaces to intermingle. When the solvent evaporates, a hard clear joint is obtained. Recommended is cement 1-A, which is a mixture of equal parts of monomeric methyl methacrylate (inhibited with hydroquinone) and methylene dichloride.

This cement is apt to lose its methylene dichloride component more rapidly than its monomer component through the higher rate of evaporation of methylene dichloride and the preferential absorption of methylene dichloride. The specific gravity of the mixture provides a quick method of checking the relative proportion of the two components and is practically independent of the amount of plastic dissolved in the cement. Cement may be properly controlled by keeping the sp. gr. within the following ranges at the given temperatures:

Temperature		Permissible Range
C.	F.	Sp. Gr.
20°	68°	1.13–1.18
25°	77°	1.12–1.17
30°	86°	1.11–1.16
35°	95°	1.10–1.15
40°	104°	1.09–1.14

If cement is used continuously, the sp. gr. should be checked at least every 4 hr. and more often if the check shows an excessive change of composition. If not used continuously, check sp. gr. before each use. If the sp. gr. falls too low, the proportion of monomer is too high and the cement does not form a deep soft cushion on the plastic. Furthermore, if the assembly is subject to any stress in a jig, severe crazing will result, reducing the strength of the joint. If the sp. gr. is too high because the proportion of the methylene dichloride is over large, excess cushion will be formed too quickly and the cushion will crust over rapidly, sometimes so fast that "blushing" (a frosty appearance in the joint) will result.

Check sp. gr. with a high grade storage battery hydrometer. At 25 C. (77 F.) this mixture should read 1.13. If the hydrometer reading differs from this value, a correction factor should be applied to all readings taken with the instrument. If at time of checking, the sp. gr. is found to be too low, it should be adjusted by adding methylene dichloride to bring its sp. gr. to the maximum end of the specified range.

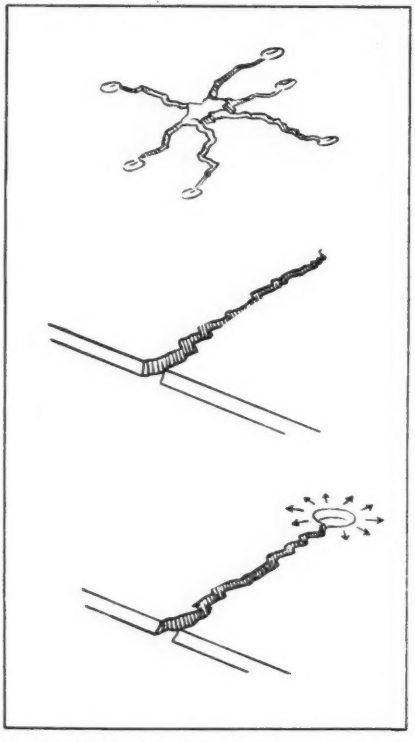


Fig. 3. Holes should be drilled at inner ends of cracks to prevent stress concentration at these points from extending fissures.

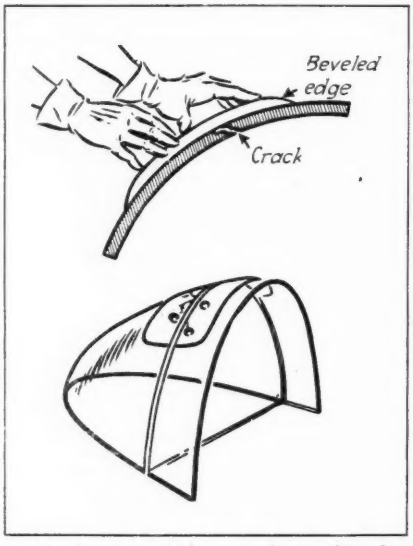


Fig. 4. Curved patches are bent while hot over surface to be repaired (top) and cemented patch is held in place until cement is set (above).

After thoroughly stirring the cement, recheck sp. gr.

While working with this cement, adequate ventilation is essential because methylene dichloride vapors are toxic if inhaled. Always direct fresh air to remove vapor concentrations from the enclosure being worked on. Because this vapor is heavy the source of fresh air should be as high above the floor as possible.

Another acceptable cement is H-94, a proprietary mixture similar to 1-A but which does not require the use of a catalyst. The same precautions exercised with cement 1-A should be observed.

In the absence of these cements, methylene dichloride may be used. This substance is a more active solvent than 1-A, and shorter soak periods should be used. Methylene dichloride is also more apt to cause "blushing". In emergencies monomeric methyl methacrylate, acetone or glacial acetic acid may be used. Monomer does not create as deep a cushion as 1-A and is more apt to cause crazing. Acetone usually causes a cloudy, unsightly joint of inferior strength, and it is highly inflammable. Glacial acetic acid, which is irritating to the skin and eyes, should be handled only with rubber gloves.

Acrylic plastic sheets have a highly polished, perfectly transparent surface and should be handled carefully so that unnecessary finishing operations may be avoided. If the sheets should become scratched, ordinary buffing is initially indicated to remove these blemishes, or when buffing equipment is not available, a good cleaner or polish can be applied by hand to remove light scratches. The polishes used for this purpose should have no chemical action on acrylic plastics.

The area to be polished should be washed. To remove grease and oil, wipe with a clean, soft cloth soaked in kerosene or hexane. Because window cleaning compounds may contain solvents, their use should be avoided. Use a soft, damp cloth, and rub vigorously, taking care not to rub too long in one place. Rub with a free circular motion over a fairly wide area. Several applications may be necessary.

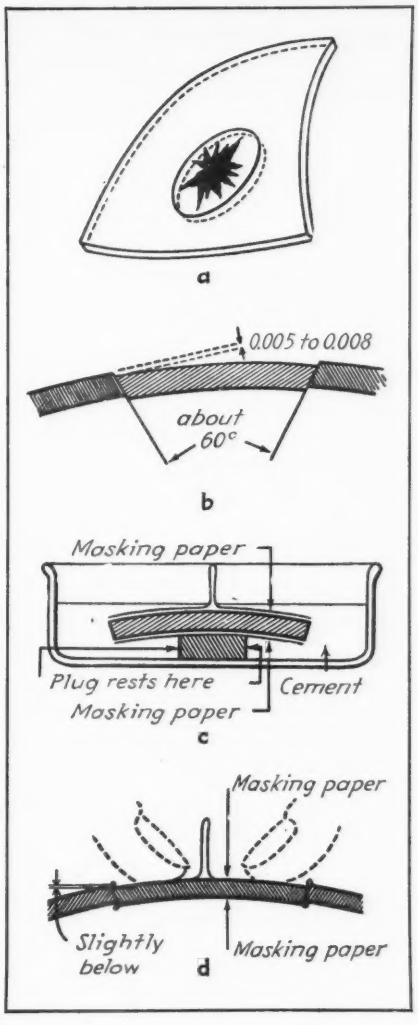


Fig. 5. Holes are cut out beyond damage (a) and 60-deg. patch plug is cut to fit slightly below surface of sheet (b). After masking with paper, patch is immersed in cement to soften edges (c) and is then set in place, using wrinkle in masking paper as handle. When completely set, repair is smoothed and polished.

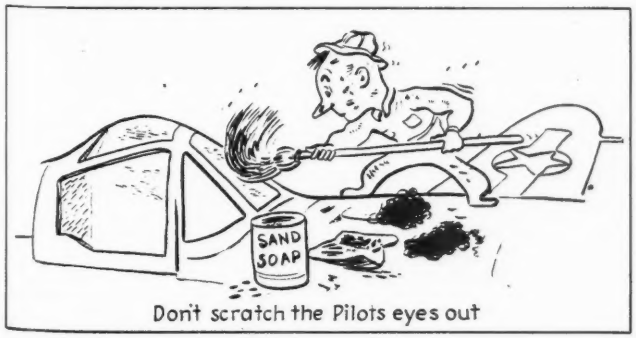
If blemishes cannot be removed by polishing or buffing, sanding is in order. However, sanding should not be attempted unless some type of mechanical buffing equipment is available, since hand polishing is not sufficiently effective to restore a polish to a sanded surface. First use the waterproof sandpaper (no coarser than No. 320). Wrap the sandpaper around a felt or felt covered wooden block (see Fig. 2). Rub the defective area lightly, using water or a 2% soap solution as a lubricant. Light pressure should be used and the strokes should be circular—not straight back and forth. An area of two to three times the length of the defect should be sanded, to minimize optical distortion and excessive thinning.

The initial sanding should be followed by similar treatments using successively finer grade of sandpaper grits in the following sequence: 360A, 400A, 500A, and 600A. During each step scratches left by the preceding grade of abrasive are removed.

Observe the same procedure when sanding with a power-driven sanding machine. The same succession of sandpaper grits should be used, and water should be employed in generous quantities to dissipate frictional heat. Power sanders should not be used except where the extent of the defect is such as to require excessive sanding. In such cases only the flat surfaces or the sur-

(*Turn to Page* 255)

Don't clean me with gas or I'll go craze-y



Don't scratch the Pilots eyes out

Don't wash my face with that dirty cloth

Whipping Corrosion BEFORE IT STARTS

By **PAUL BATTILANA,** *Sales Manager, Edo Aircraft Corp.*

Preventive maintenance on both planes and floats is less complicated than it sounds. Actually, periodic inspection to guarantee uninterrupted service can be accomplished with comparative ease.

THE BUGABOO OF SALT-WATER corrosion, which for years was the bane of seaplane flying operations, has been licked to a large extent. This conquest has been achieved through a number of factors, such as the development of Alclad, metallizing of metal parts, waterproofing compounds, stainless steel cables, and improved service technique recommended by Edo Aircraft Corp., manufacturer of Edo floats and pioneer builder of seaplane equipment.

The ever-potent effects of salt water still threaten, however, and a certain degree of preventive maintenance for seaplanes operated in salt water continues to be necessary—maintenance which, if followed properly, virtually removes the possibility of deterioration of aircraft structures under most operating conditions.

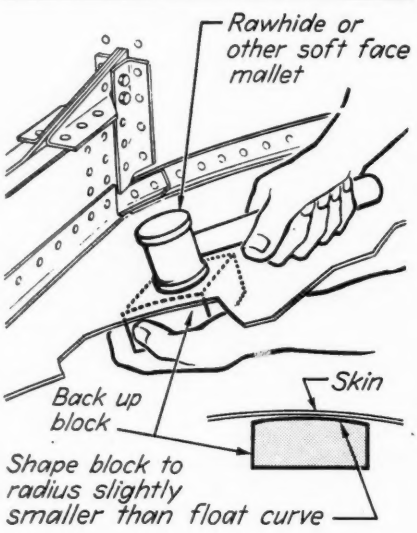
Preparing the Airplane

Much of the job of keeping the rust out of seaplanes is completed before the airplane ever flies or at least before the plane is installed on floats. Steel members of the fuselage both inside and out should be treated with special paints and special greases, for the salt air can penetrate wings and fuselages and cause corrosion as well as actual salt spray.

It is naturally better to have an airplane prepared for salt water use while it is being manufactured, but highly satisfactory corrosion-proofing of airplanes already built can be effected through a number of reasonably simple procedures.

In the case of converting a landplane already constructed or preparing one in the factory, one of the most important points where protection is needed is the interior walls of the fuselage tubing.

This is accomplished either at the factory or in the field by filling the tubes with a rust-proof lubricant and then draining. This process is called internal oiling. While it is simpler to accomplish when the fuselage is still uncovered in the factory, it can be done satisfactorily to an airplane already assembled.



Minor float repairs can often be made in average shop so that plane can be kept in completely airworthy condition with minimum time loss. Dents, for example, that do not cause cracks or internal damage, may be pounded out by using soft faced mallet and back up block. Minimum amount of forming required to restore contour should be done to avoid cracking skin. (Edo Aircraft photos)

The procedure first calls for checking air tightness of tubes and welds. A small hole is drilled in the lower longerons near the tail post and a bicycle valve tapped in place. Through the valve several pounds of air pressure are applied to the fuselage. If the pressure holds, it can be assumed that there are no leaks. If the pressure drops, the leaks can usually be detected by listening for the sound of escaping air. Any holes found can be stopped with marine glue. Even when a fuselage is covered, it is usually possible for a man to crawl aft into the rear section to detact and stop such leaks.

After the pressure test has been completed, the oil should be injected so that the entire fuselage tubing is filled, thus bathing all the interior surfaces with a protecting film. Linseed oil used to be used for this and is still considered satisfactory. However, a new and improved rust proofing liquid is Rust Veto (A-7) manufactured by the Houghton Co. This may be injected cold, and then drained after the fuselage has been thoroughly filled. The drain hole, of course, should then be plugged.

One of the most effective treatments for the exterior of metal parts is the metallizing process which coats the surface with a layer of pure molten aluminum. Such treatment is normally possible only at the factory and at the time of original construction. Some manufacturers treat every steel part from throttles to wing compression ribs in this manner and the results are quite effective.

In the case of airplanes already built adequate protection of fuselage and wing interiors can be accomplished by spraying a fog of grease. For this purpose a reasonably heavy grease which can easily be melted and handled in a gun is used. "Corol" No. 135 Special, a Simoniz product, is recommended by Edo.

To apply the fog spray all inspection holes and other apertures should be opened in the wing or fuselage to create maximum ventilation. The grease should be kept hot and the gun adjusted for the finest possible spray. Care should be taken to keep the gun moving to prevent excessive deposits of grease on any one spot of fabric. In fogging a wing, the gun should be aimed through a hole near the root, for instance, and used until the fog can be seen emerging from a point near the

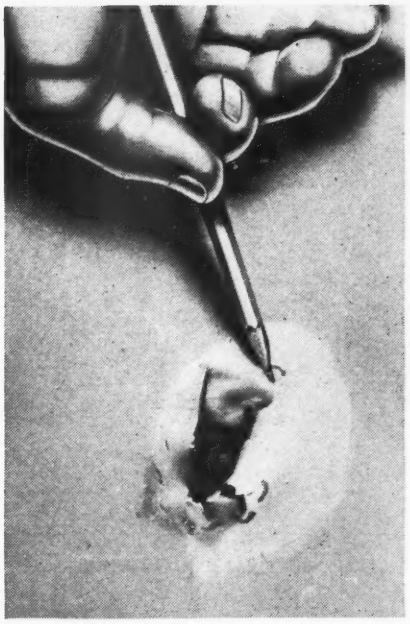
wing tip. That will indicate that the entire wing has been covered by the grease fog. It is recommended that the process be undertaken on a cool day and out of the sun.

Other treatments recommended for planes not previously corrosion-proofed include several other procedures. Any accessible fuselage members should be given a good coat of zinc chromate primer and, where possible, fairing strips should be added to cover exposed parts. In addition all unnecessary openings in the wing and fuselage should be covered to keep the salt spray out. This would include holes in the fuselage where the tail wheel was installed or where the landing gear struts entered the fuselage. Small holes in the fabric can be covered by industrial adhesive tape.

At all low points of the wings, fuselage and control surfaces scoop type grommets should be installed to allow drainage of any accumulated moisture in the interior.

All exposed parts such as pulleys, control hinges, strut ends, etc. should be coated with a corrosion resistant compound. Several different types have been used in the past but one recommended for most uses and found well suited is Par-al-ketone, a brown, waxy semi-plastic with a consistency approximating that of grease. Particular care should be given in the treatment of piano hinges.

In service, the greatest potential corrosion points are around longerons and other metal parts which are in contact with the fabric. At these points the moisture is pocketed between the fabric and tubing which leads to faster corrosion. Periodically, the fabric should be opened to inspect these sections and extra precautionary priming should be incorporated.



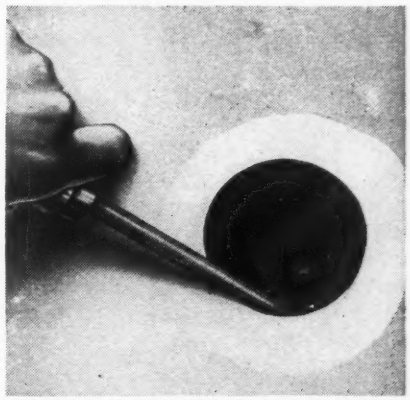
Skin damage or punctures not over 6 in. in size can easily be repaired temporarily. First step, as shown here, is to remove paint and carefully examine for cracks and tears so that all damaged area will be cut out.

Of the engine parts, the major item affected by salt water operations is the exhaust pipe. Here again metallizing has been found to reduce almost to zero the inroads of corrosion and practically all new exhausts supplied on airplanes today are metallized whether for seaplane or landplane operation. Metallizing cylinder barrels and heads, as well as the tops of sparkplugs, with pure aluminum also reduces engine deterioration.

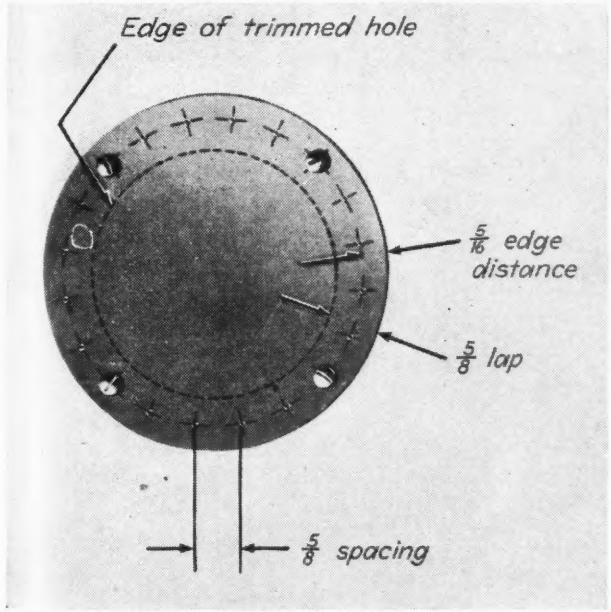
Plane and Float Maintenance

Once an airplane has been treated according to the procedures mentioned above for corrosion-proofing, the job of keeping it in good shape is not finished; however, the problem is pretty well licked. Definite daily maintenance procedures, involving neither a great deal of time nor skill, complete the job of keeping the airframe and controls in airworthy condition.

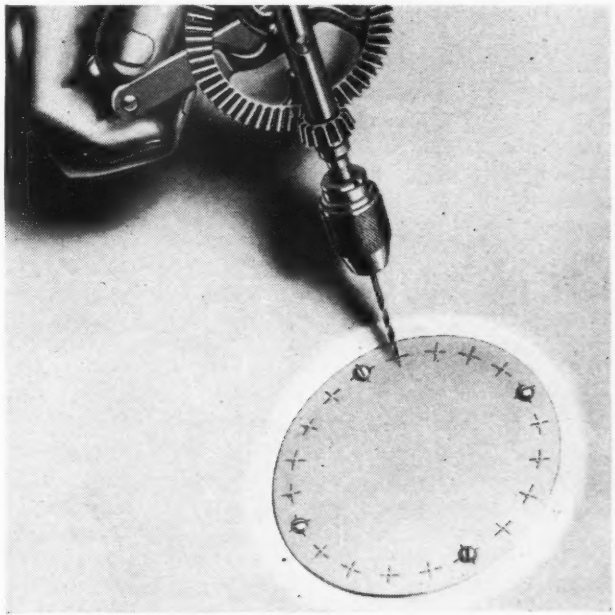
A fresh water hose and a Flit gun represent the major equipment needed. The plane should be hosed down after a day's operation to remove salt spray which might work on the metal parts



Second step in hole repair is to cut out damaged area to form symmetrical hole with sound metal all around, then smooth hole edges with file.



Third step is to cut patch plate—which will overlap hole by 5/8 in.—from Alclad 24ST at least one thickness heavier than skin being repaired, then lay out and center punch row of holes 1/16 in. from edge of patch and spaced 5/8 in. on centers.



Fourth step is to drill three or more holes in patch and skin and attach with screws, then drill balance of holes and remove patch plate and burr holes. Use drill no. 32 for round head sheet metal screws; drill no. 20 if no. 8 steel machine screws are used.

during the night. The hosing should be done from the front of the plane to avoid driving water into the drain grommets of the wings.

After hosing, Edo engineers further recommend that the engine, control surfaces, and other moving and exposed parts, be sprayed with a light film of penetrating oil from a Flit gun.

Few if any of these precautions need be taken if the airplane is to be operated exclusively in fresh water, since the moisture induced by water flying is no more than that picked up from dew and rain by an airplane stored in the open. But if there is any possibility that the airplane is to be used on salt water, even occasionally, it should be thoroughly corrosion-proofed.

Despite what would seem to be extreme measures necessary to corrosion-proof an airplane for salt water operations, it has been found in actual practice that land airplanes based near the seashore show almost as much deterioration from salt air as if the airplane were actually used on the water.

The maintenance of the seaplane is centered almost entirely on the airplane itself, since current manufacture of metal floats has entirely eliminated corrosion except in tropical salt water which is much more potent. What corrosion occurs appears in the form of small white spots, usually found near the rivets. They have an appearance similar to barnacles. The difference between corrosion spots and barnacles (which have no detrimental effect on the float) can be determined by wiping off the surface. The barnacles wipe off very easily and the paint is unaffected, while corrosion spots actually blister the paint and leave small pits in the metal.

If such pit marks are found they should be carefully, yet thoroughly, scrubbed or wire brushed before new primer and paint is applied. Care should be exercised in scrubbing the metal surface so that the protective layer of pure aluminum on Alclad as well as the anodic film is not removed.

One of the reasons why floats seem expensive is the fact that they must not only be made light, strong, and aerodynamically and hydronamically correct, but also water-tight. The combination of these requisites results in engineering and production problems far in excess of anything the manufacturer of an aircraft must encounter.

Metal floats retain their watertightness to a remarkable degree, but hard landings, drying-out of seam compound, etc., produce small leaks from time to time.

Testing floats for leaks is accomplished by filling compartments with water—one at a time—and observing where the water is coming out, either through the bottom or sides, or through bulkheads. Since this must be done when the plane is out of water, care must be taken in cradling the floats properly to withstand the terrific weight of water put into the floats. For that reason it is recommended that only one compartment be filled at any one time.

Minor seepage between bulkheads is permissible, unless the airplane is moored in the water over an extended period of time. Any outside leak should be stopped. Application of either Bakelite Seam Compound or Dolphinite will cure minor leaks, but before application the old compound should be removed. In the event of excessive leaks, the rivets may have to be tightened. This is done by holding a heavy bucking bar inside the float and hammering lightly on the loose rivet. In the case of stubborn leaks, several rivets may have to be removed, the old seam compound replaced, and new rivets installed.

Refinishing Floats

Every year or so, refinishing and repainting of floats is important to provide maximum corrosion-proofing. With the aid of a good paint remover, the paint should be cleaned off and any corroded spots polished up. Before painting, two other steps should be followed: The metal should be cleaned with a good cleaning solution, such as Valentine's No. 1004 Solvent, and then followed up with vinegar. The vinegar plays an important part in neutralizing the solvent and providing a good bond for the paint. Care should be taken in using the solvent so that it does not seep into the seams, since it dissolves the seam compound and would create additional leaks. Under no circumstances should gasoline be used as a cleaner since it leaves an oil film on the surface.

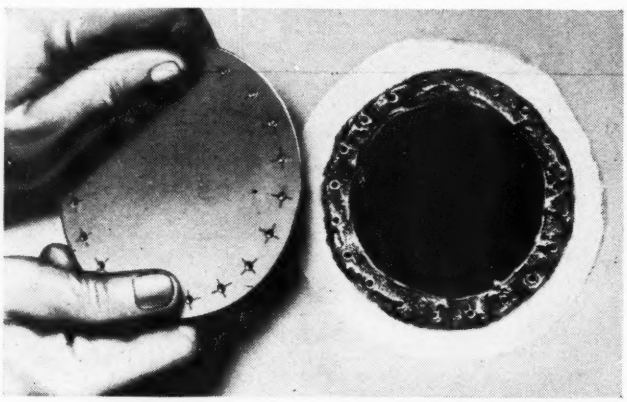
Before the paint is applied, a thin coat of zinc chromate primer should be applied and then two coats of pigmented lacquer sprayed on. Edo recommends a combination of 2 lb. of extra fine aluminum powder, added to 2 qt. of lacquer thinner, then, after thorough stirring, addition of 1 gal. of clear exterior lacquer, mixed in. A good substitute for this is painting the floats with a good grade of salt-water-resisting paint or enamel. The inside of the floats should be periodically painted or sprayed with zinc chromate primer, preparation of which was described earlier.

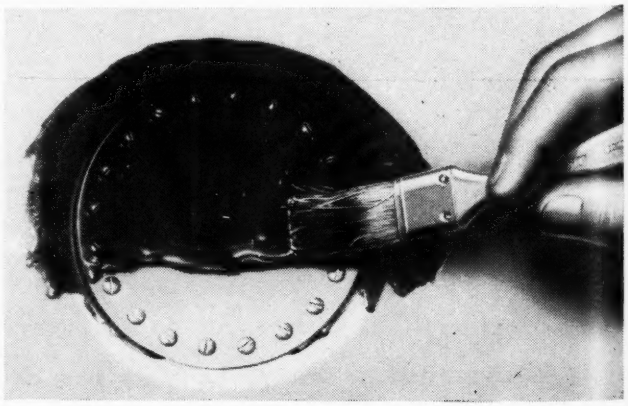
Launching and Beaching

One of the advantages of metal floats over other types is their ruggedness. Extremely severe bumps against docks, or collision with floating objects, can normally be withstood by metal floats. However, there are a few precautions to be observed—particularly in launching, hauling out, and when the airplane is on land—and these precautions will add materially to the length of the float's life.

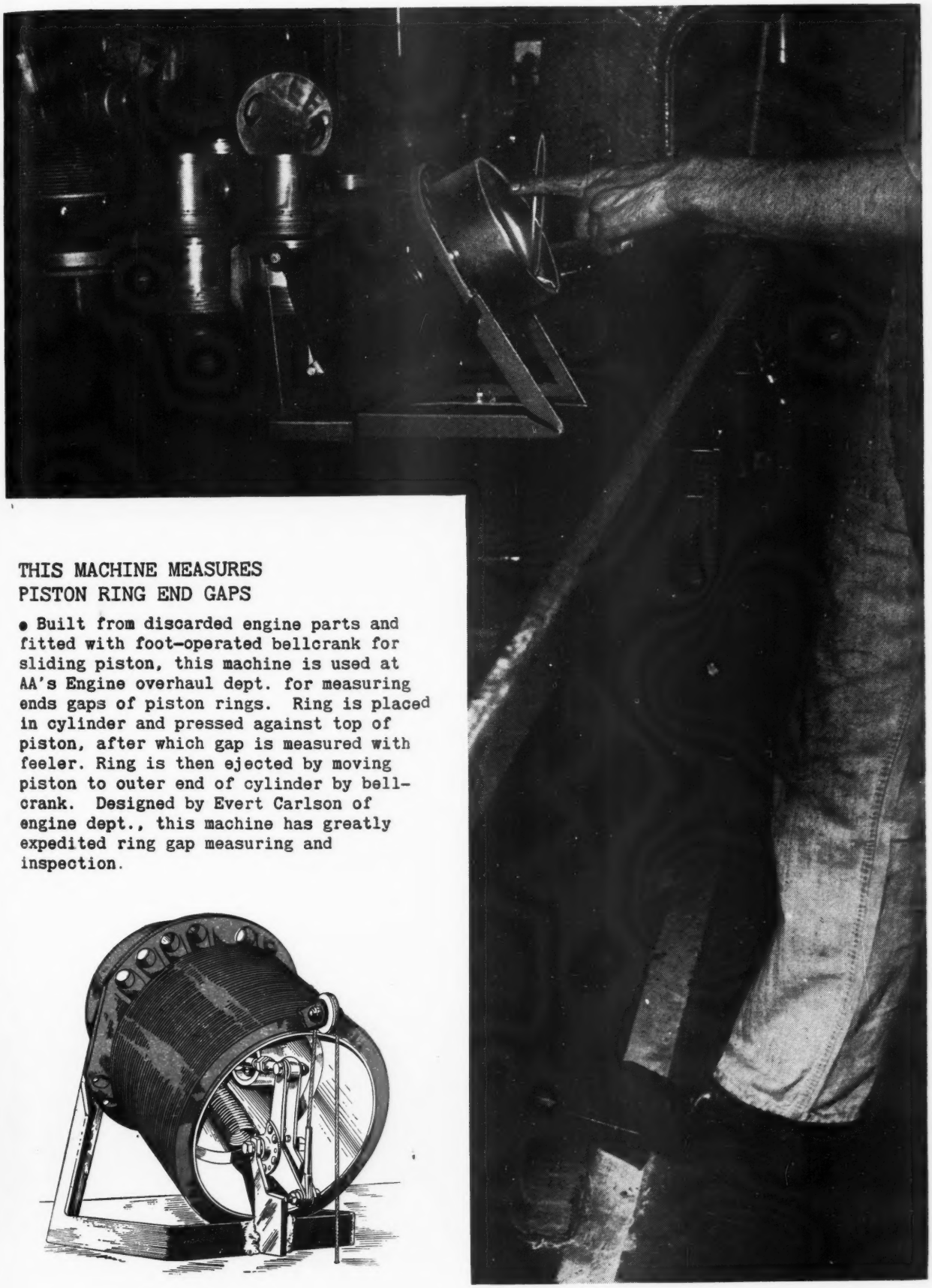
Primarily it is important to understand the construction of the floats. Forward of the step the floats are designed and built with very heavy keels which can carry the entire weight of the plane on dry land. Damage can be incurred, however, if the load is not

(*Turn to page* 252)





Final two steps are to apply zinc chromate compound around hole and screw patch plate in place; then cover patch and surrounding area with corrosion-resistant compound such as recommended Par-al-ketone.

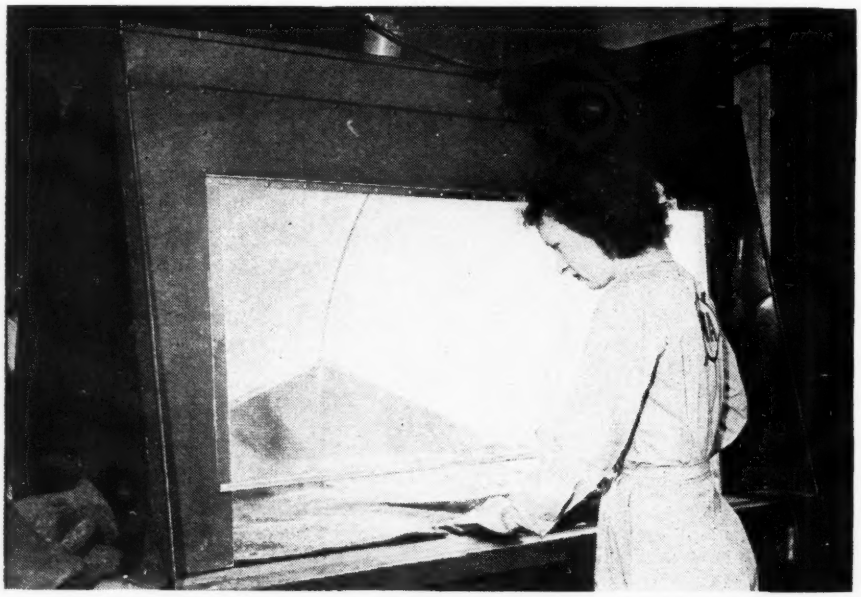


THIS MACHINE MEASURES PISTON RING END GAPS

• Built from discarded engine parts and fitted with foot-operated bellcrank for sliding piston, this machine is used at AA's Engine overhaul dept. for measuring ends gaps of piston rings. Ring is placed in cylinder and pressed against top of piston, after which gap is measured with feeler. Ring is then ejected by moving piston to outer end of cylinder by bellcrank. Designed by Evert Carlson of engine dept., this machine has greatly expedited ring gap measuring and inspection.

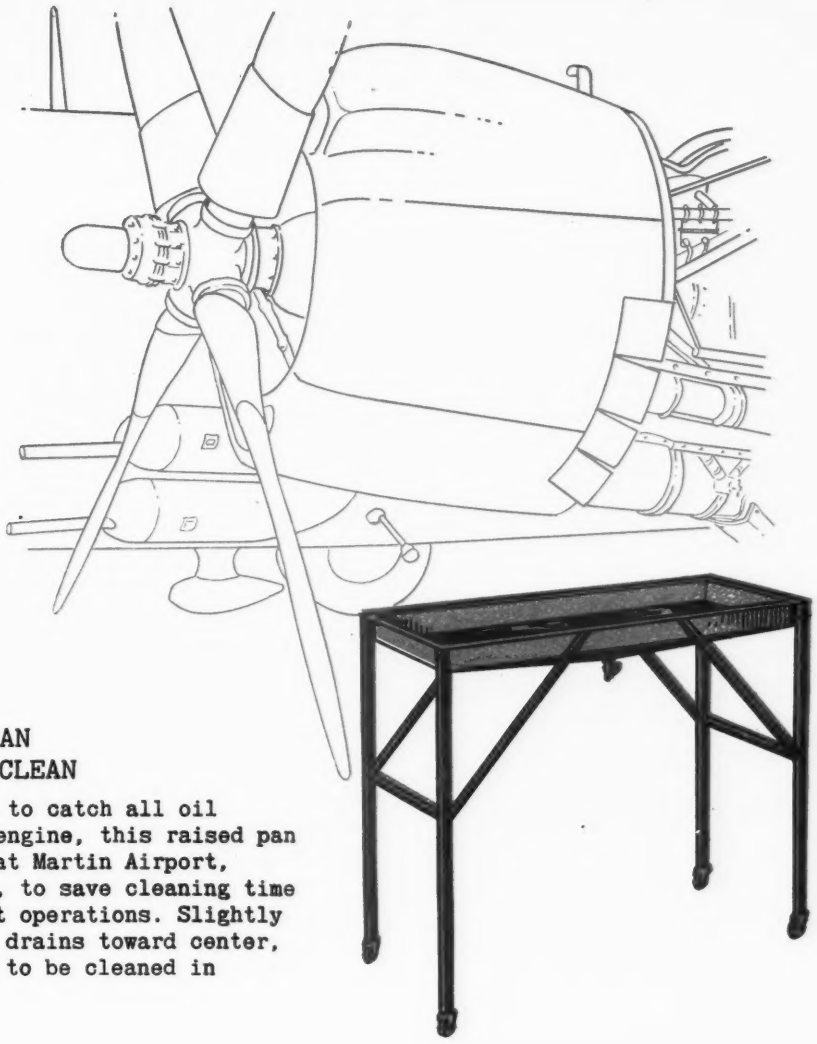
STILL RECLAIMS 90 PERCENT OF CLEANING FLUID

● Saving 1,200 out of every 1,500 gal. of carbon tetrachloride and trichlorethylene used by ATSC for engine cleaning, this still, constructed by Lt.G.W.Hoffmann effects economies of $1,000 per month in cleaning fluid.



VACUUM CABINET CLEANS CABIN RUGS

● Drawing air through space at bottom of window and out at rear, vacuum-operated aircraft cabin rug cleaner is used by TWA to safeguard employees from dust which might otherwise render this operation somewhat hazardous. Operator blows air under rug from air hose, which is moved to whatever place is being worked upon.

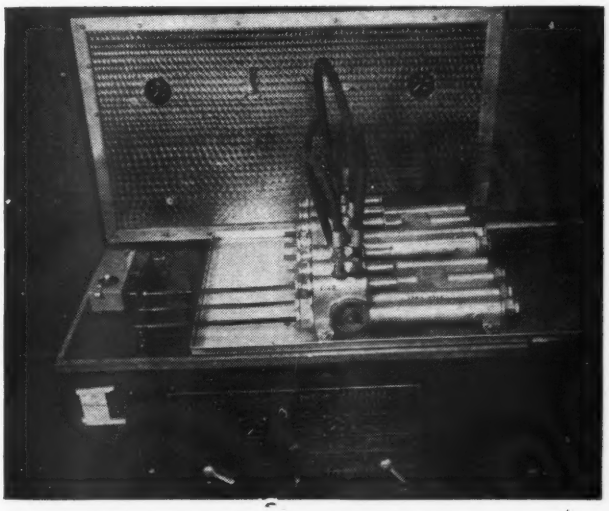


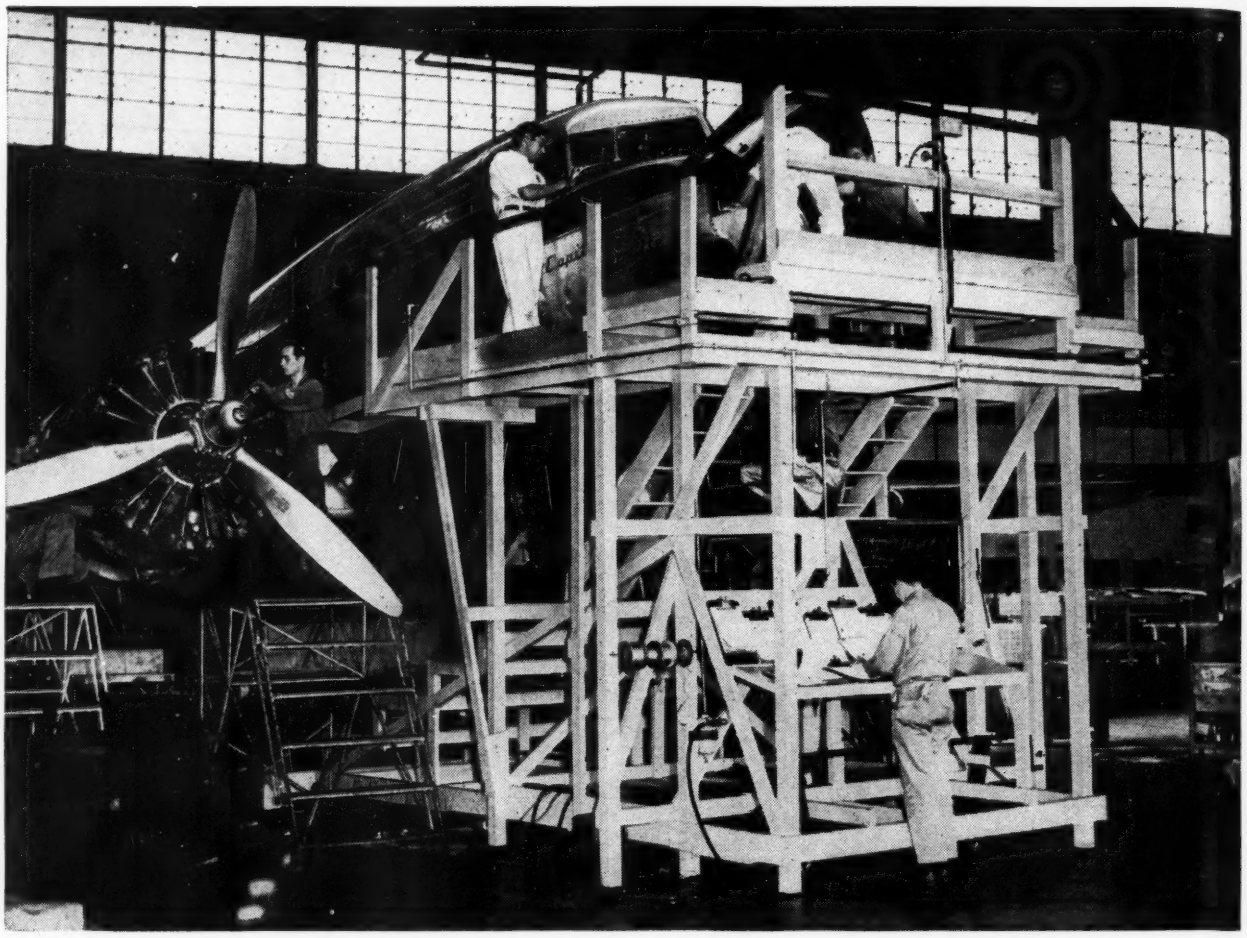
RAISED OIL PAN KEEPS FLOOR CLEAN

Large enough to catch all oil dripping from engine, this raised pan was developed at Martin Airport, Baltimore, Md., to save cleaning time after preflight operations. Slightly tapered bottom drains toward center, permitting pan to be cleaned in minimum time.

SERVO EXERCISER HANDLES SIX UNITS

For running in servo units and setting overpowering valves this electrically controlled unit has been built by AEA's instrument dept. Oil flow is controlled by rocker at left hand end of table, which is snapped over center by servo piston rod at end of outward stroke, reversing action of all six units. When piston rod of opposite set of servos strikes other end of rocker, motion is again reversed and cycle is repeated. Pressure of incoming oil is shown in lower gages and that of exhaust oil by upper ones.



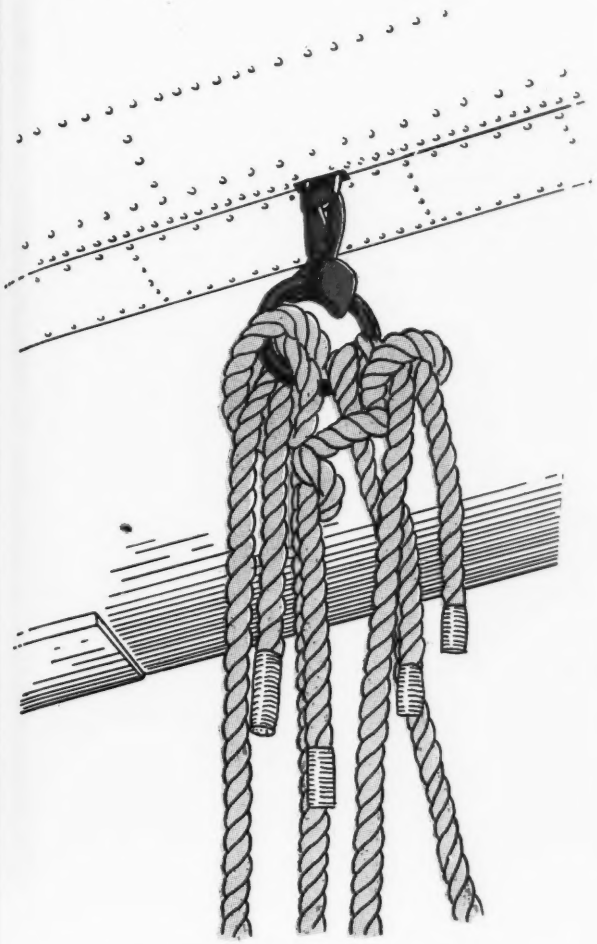


IMPROVED NOSE DOCK ENHANCES CREW EFFICIENCY

● Complete with multiple electrical outlets, air and water service to upper and lower levels and a desk with space for all servicing records, PCA's new nose servicing dock enables a full repair crew to work on plane's front end without necessity for leaving positions to make connections to outside lines.

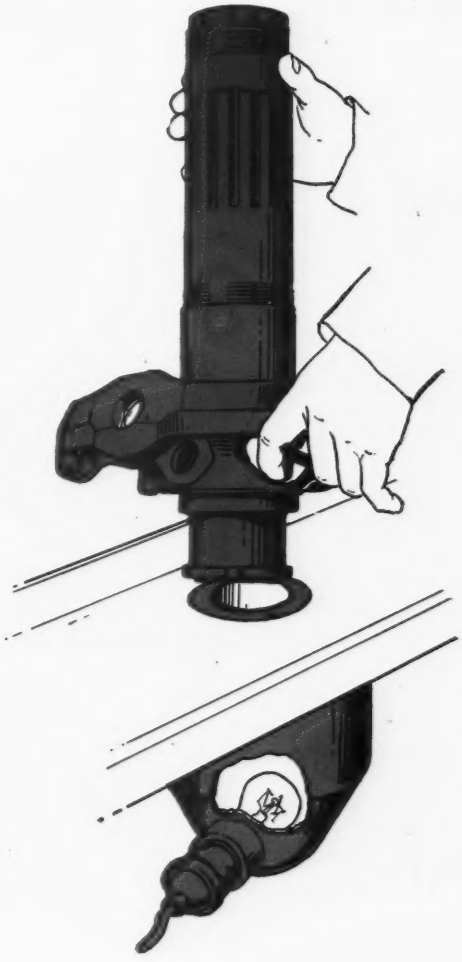
WOOD SHIPPING BLOCK PROTECTS AND STORES PLUGS

● Held together with tape when shipping, these blocks are used to hold sparkplugs for transmission to service stations from UAL's Cheyenne base. When changing plugs, mechanic places old ones in top half until bottom half is emptied.



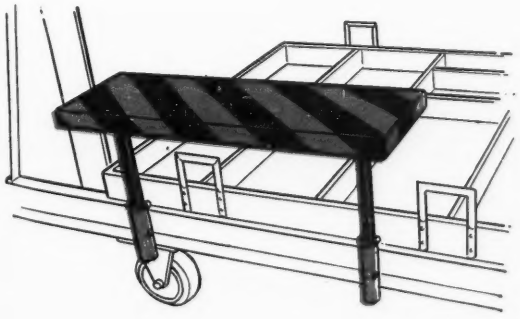
THIS SNAP RING CUTS TIE-DOWN TIME

Using a steel ring and snap instead of tying four knots at each tie-down point, mooring time at Wright Field has been reduced to a few seconds, whereas it formerly was necessary to tie four knots at each place, an operation occupying several minutes.



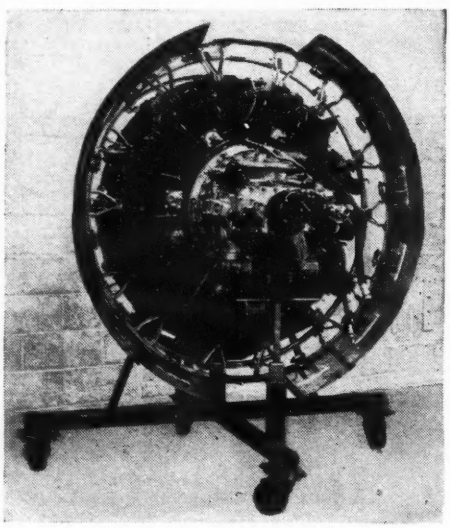
LIGHT UNDER BENCH FACILITATES INSPECTION

Using a light which shines through a hole in inspection bench, instead of a flashlight, propeller shaft inspectors at Wright Field are enabled to perform work without eyestrain. W.A.May, chief engine case inspector, reports that visibility of details is greatly improved by new device.



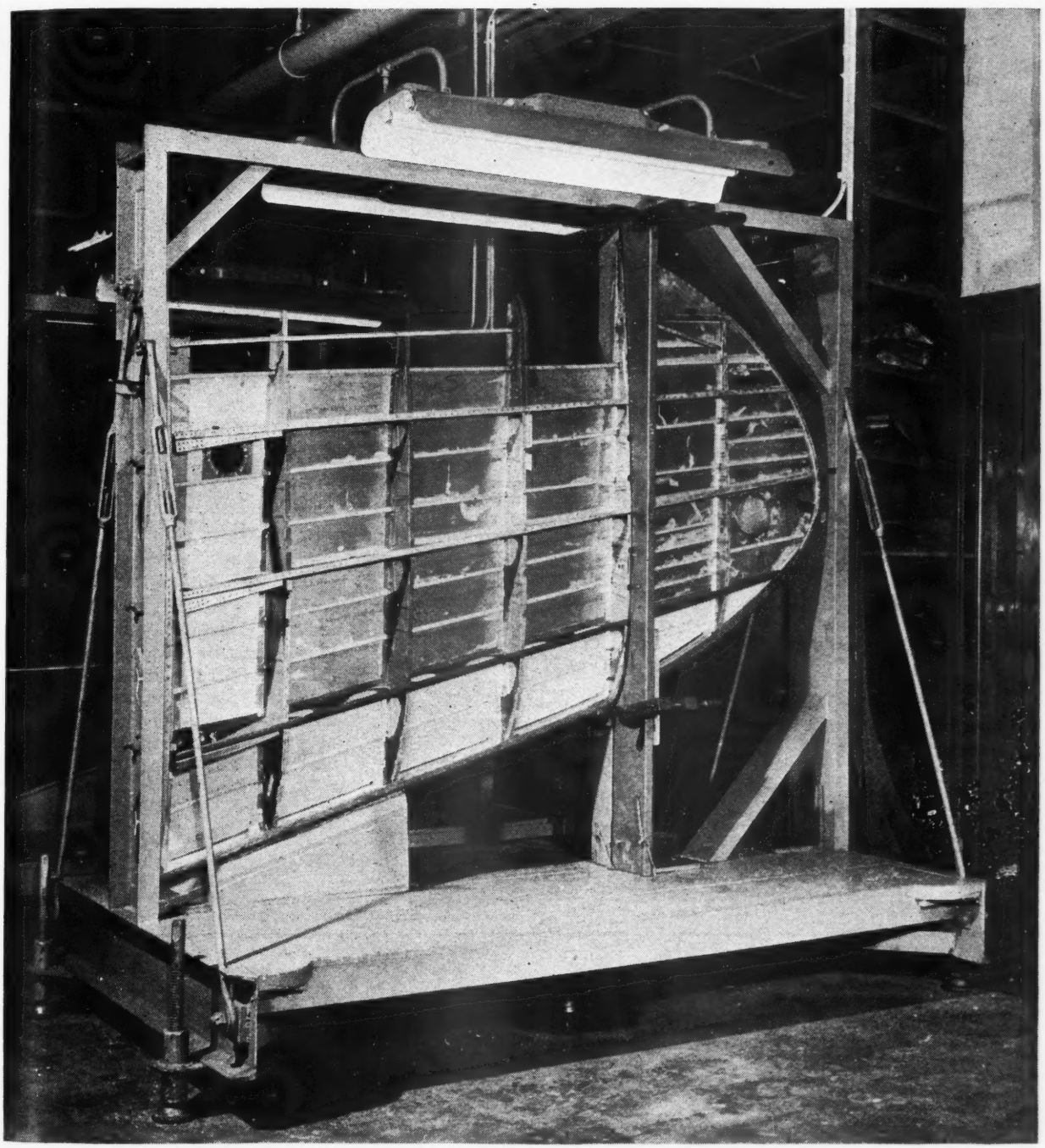
DETACHABLE PLATFORM IMPROVES ENGINE STAND

To provide safe footing during engine assembly, this removable platform was devised by Lewis C. Miller of Gardner Field, Taft, Calif. Bracketed into tubing welded to sides of stand, platform is adjustable in height by pins through tubular supports. Materials are: 2 ft. of 1½ tubing, 5 ft. of 1¼ tubing; four steel plates, ¼ x 2 x 8; two planks, 2 x 12 x 36; sixteen ½-28 x 2 FH machine screws, and four pins ⅜ x 2 for height regulation. (ATSC photo)



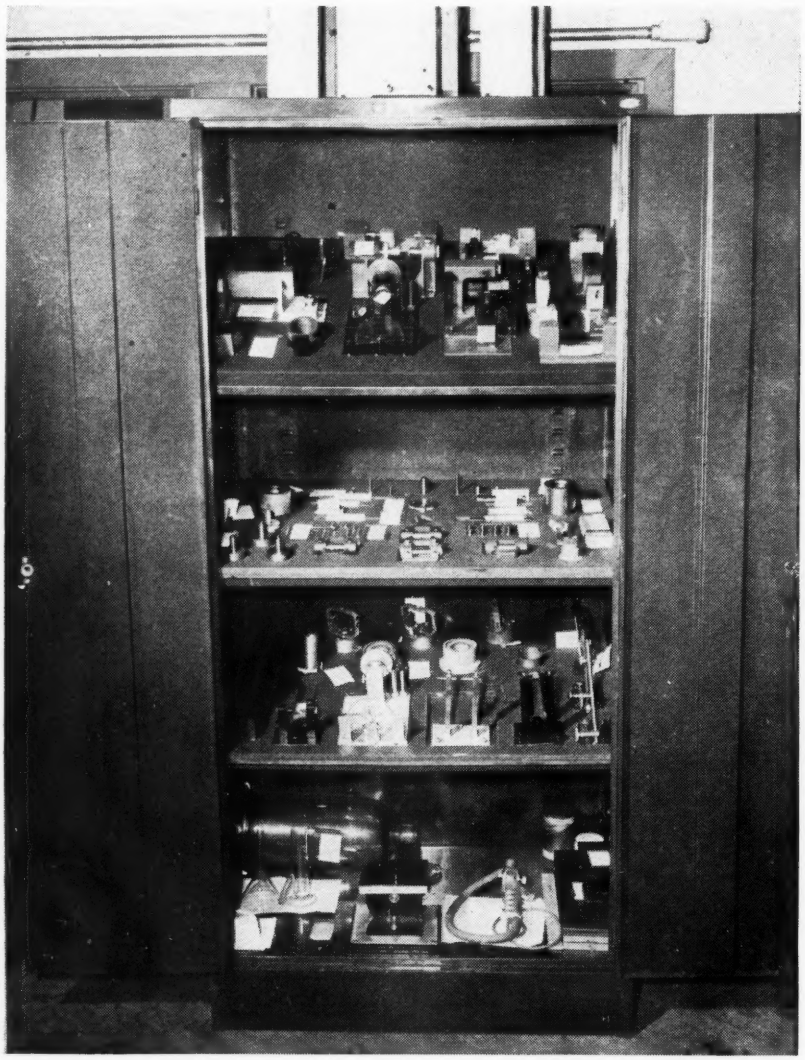
ACCESSIBILITY IS FEATURE OF ENGINE ASSEMBLY STAND

• Combining rigidity with convenience of access to all parts of engine, this caster-mounted assembly stand permits all accessories to be attached to engine while in position. X-shaped base permits several mechanics to work at same time without necessity for platforms or other obstruction to free movement. Front end clamps over propeller shaft by insertion of one pin in hinged cover, while rear support is adjustable vertically to accommodate various types of accessory mounts. Designer is P. Solomon of AA's maintenance dept.



ADJUSTABLE WING TIP JIG INSURES SPEEDY ALIGNMENT

• Equipped with foot jacks, turnbuckle braces and mercury-vapor lights, AA's DC-3 wing tip jig permits rapid alignment of work, with no change or later deformation through lack of stiffness. Leading edge of wing rests on padded block, while vertical standards retain work in position. Endwise rigidity is obtained by bolting through center of left hand upright into rib of wing tip. Jig may be moved by raising jacks and rolling on swivelling center truck.

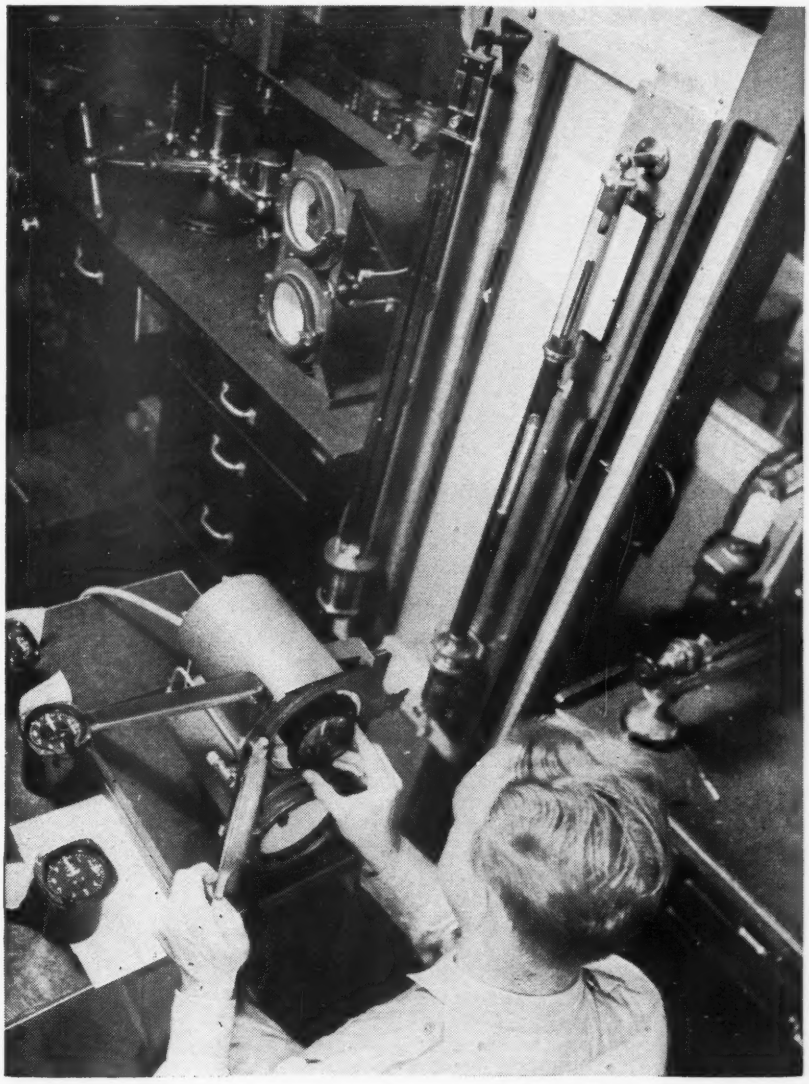


SLOPING SHELVES IMPROVE INTERIOR VISIBILITY

• To prevent damage caused by placing parts or tools on top of others invisible from in front, AOA's instrument shop uses sloping shelves, equipped with clips or blocks to prevent sliding. This simple measure has resulted in complete absence of damage, in addition to greater ease in checking tools at end of the shift.

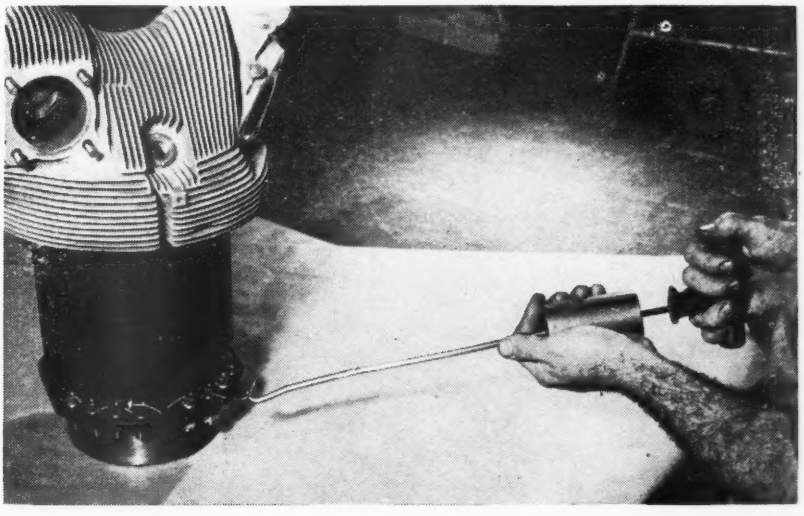
FLOATING FASTENER PREVENTS PLATE BUCKLING

• To obviate former buckling of plates in engine cowling panels, AOA uses large floating washer under Dzus fastener. Oversize hole prevents plate from buckling under stresses caused in flight.



SENSITIVE ALTIMETERS TESTED IN COMPACT BENCH UNIT

Using sealed chamber in which any combination of pressure and temperature can be applied to the instrument being tested, EAL's instrument dept. checks their sensitive altimeters through a wider range than that covered by the planes themselves. Manometers at right give readings visible from position in front of instrument in testing chamber.

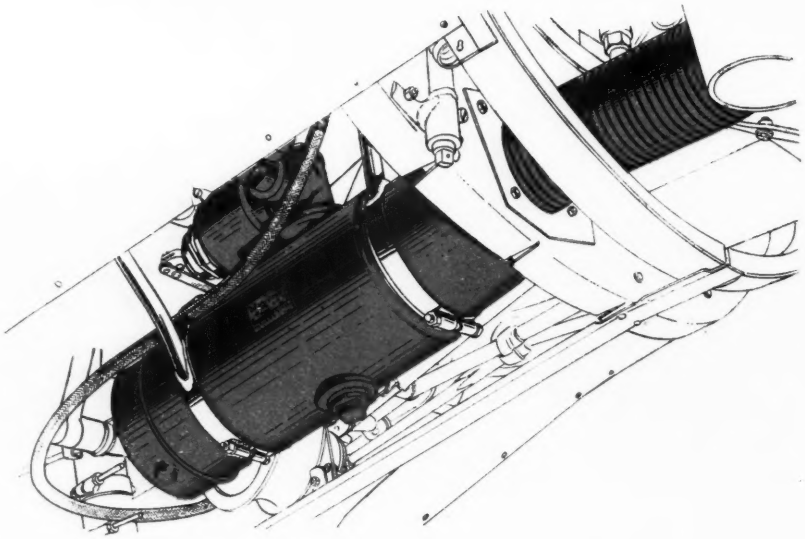


TIME-SAVING WIRE REMOVER PROMOTES HAND SAFETY

To overcome difficulty and danger of reaching into almost inaccessible places when removing safety wires at disassembly, Mechanic MacNamee of AA's engine overhaul dept. made this weight-operated wire remover, which quickly reaches places where formerly much time was wasted in this operation. Additional advantage is that mechanic's hands are not exposed to damage from contact with sharp objects as was often the case when pliers were used.

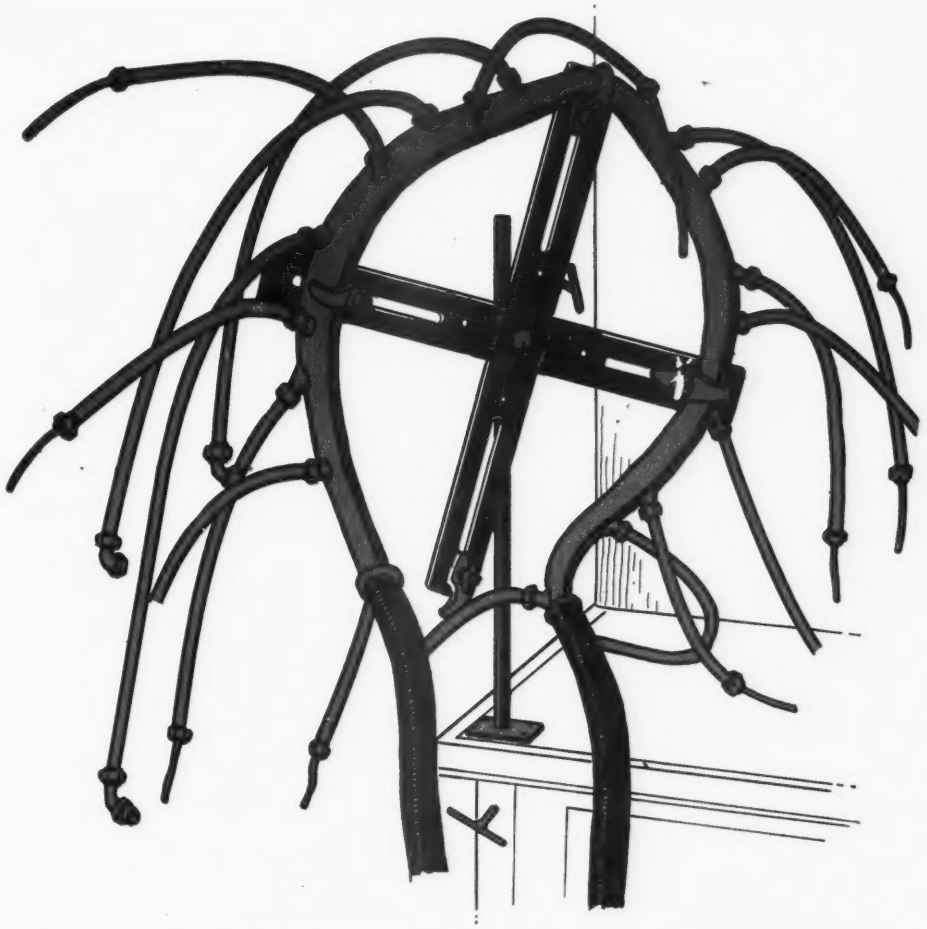
HAND-OPERATED PUMP TESTS COWL FLAPS WHEN ASSEMBLED

• Enabling cowl flaps to be tested as soon as assembled, without waiting until engine oil pumps are operating, this hand pump, with self-contained tank, has speeded final adjustments of these accessories by eliminating necessity for running engine on this test. James Waluk of AA's engine overhaul dept. is shown operating device.



OIL TEMPERATURES CONTROLLED BY THERMOSTAT

• Flying from western coastal regions to desert areas caused oil temperature trouble, until 5-in. thermostatically controlled temperature regulator was attached on Southwestern Airways cargo-carrying C-72 Wacos.

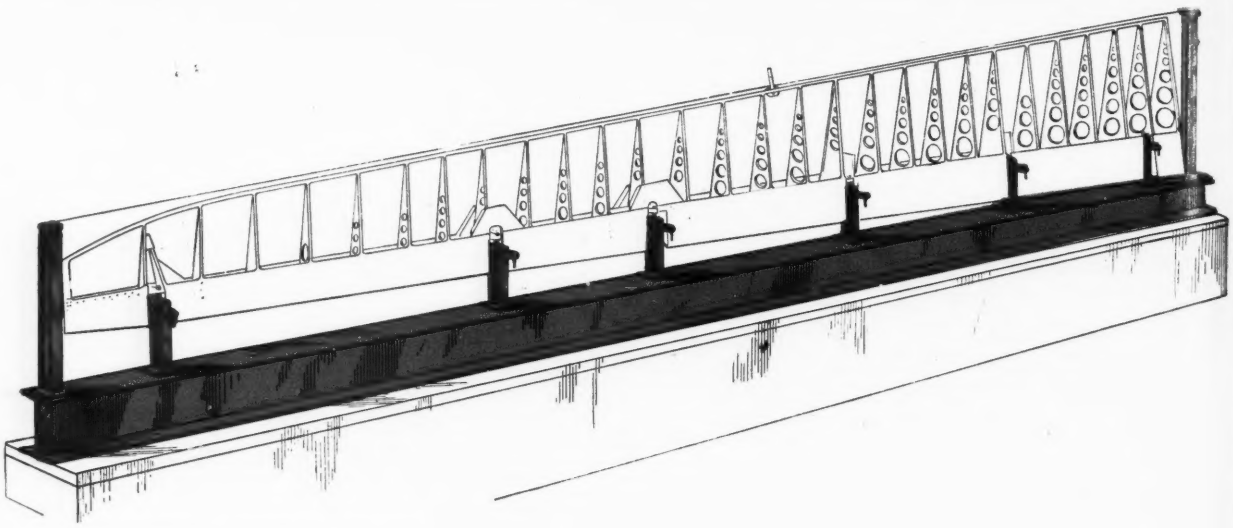


HARNESS OVERHAUL SPEEDED BY 3-WAY ADJUSTABLE STAND

• Capable of adjustment in every direction and accessible from both sides, this universal ignition harness stand will handle any size manifold at present in use. Time required for completion of overhaul has been reduced from 36 hr. to 4. Stand was developed by A. T. Stubbs, radio and electrical foreman at TWA shops, Kansas City, Mo.

STITCH MARKER SAVES MANY HOURS

• This aluminum wheel, carrying rubber inserts same length and spacing as fabric stitching on control surfaces of DC-3's, daily saves several hours of marking time in AA's upholstery shop, where covering is done. Because printed marks are same length and spacing as stitches, two tedious measuring operations are done away with by one swift movement of wheel across fabric.

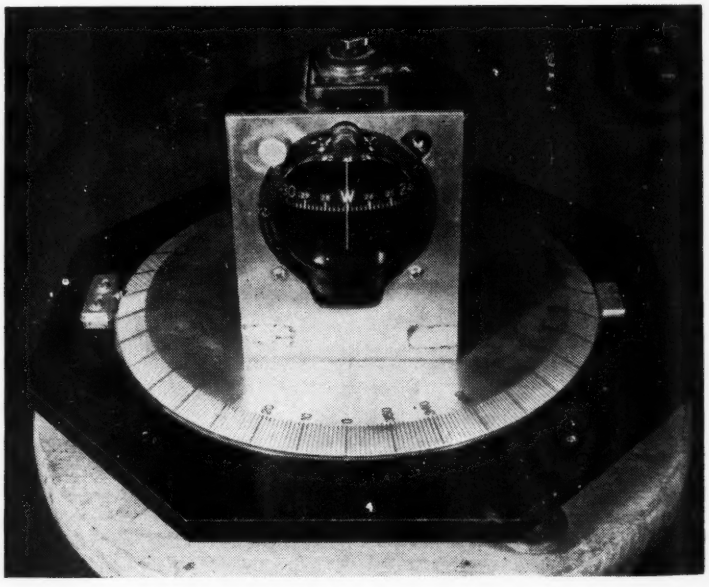


ONE SETUP AILERON STAND HANDLES ADJUSTMENT AND COVERING

● Having a concrete-mounted I-beam base, this stand is equipped with six pedestals on which aileron framework is adjustably mounted. Firmly bolted to cross members (on top of pedestals) which are adjustable vertically and sideways, work can be checked by means of tight wire between uprights at ends of stand. Provision is also made for testing balance and adding weights before removal from frame. Designed by AA's engineering dept. and Elmer Hoel, foreman of upholstering dept., this jig has solved problem of preventing aileron warping during covering process.

RIGID CYLINDER STAND IS USED FOR VALVE GRINDING

● Built of heavy pipe, set in concrete floor, this cylinder stand was designed by UAL to withstand vibration incident to valve seat refacing and valve grinding.

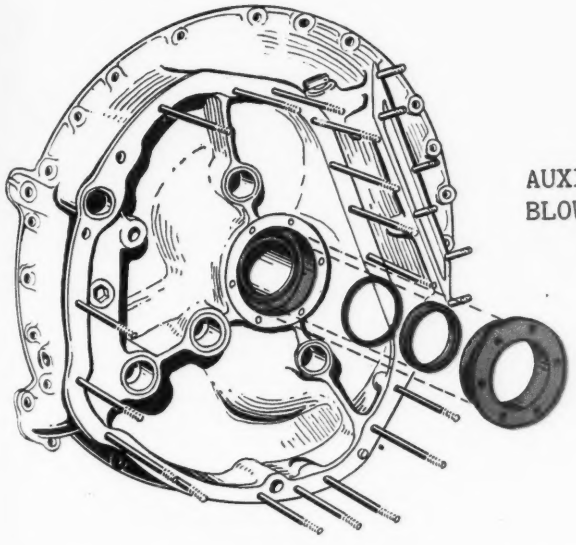


COMPASS COMPENSATING STAND ELIMINATES FIELD CHECK

● Final compass compensation on the airplane itself has been eliminated by this stand, with built in magnets to discount building and electric interference. Stand permits AOA's instrument shop to overhaul completely, check and compensate in the shop. Senior Mechanic Fred Smith designed this piece of equipment.

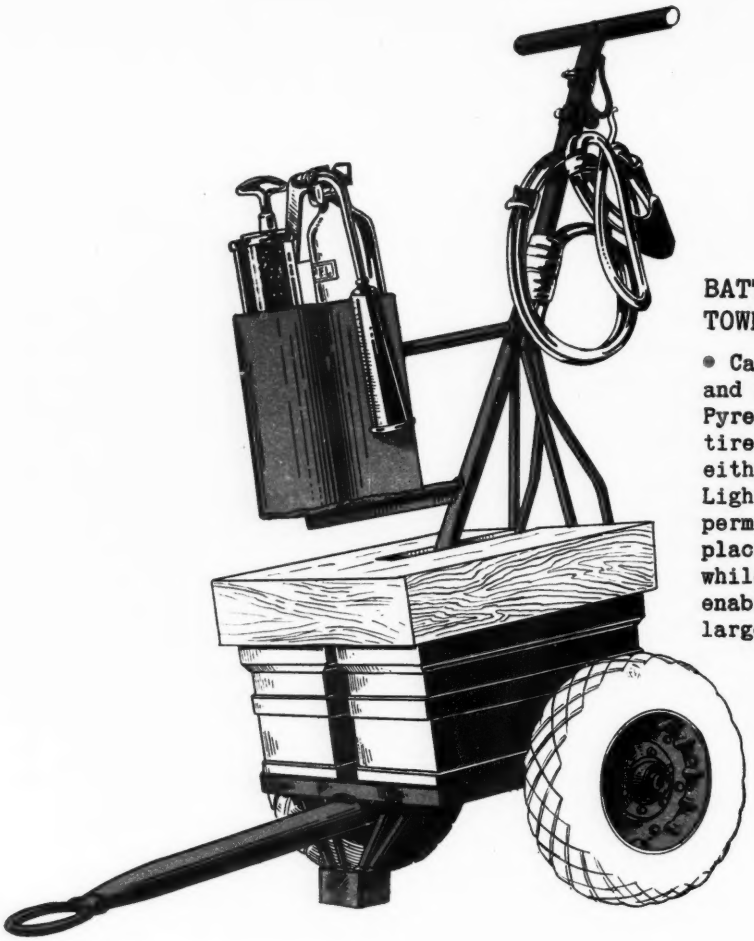
THIS WATER CURTAIN PURIFIES AIR, PREVENTS FIRES

● By means of a solid sheet of water, which washes air and absorbs fumes while falling across end of spray room, risk of fire and danger from dope-filled air have been eliminated in AA's paint dept. F. Krasniewski is shown in spray booth, designed by Elmer Hoel, foreman of dept.



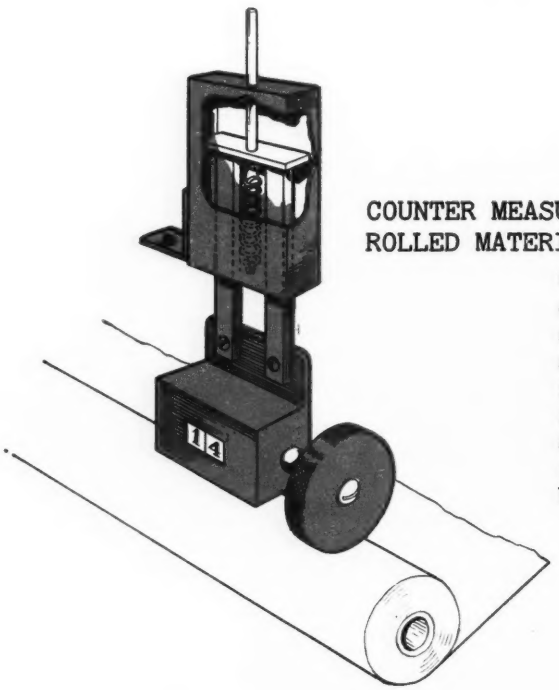
AUXILIARY SEAL PREVENTS BLOWER OIL LEAKAGE

● Removable by taking out two screws, this auxiliary seal and spacer on rear blower shaft bearing cage prevents oil leakage into blower. In addition to obviating frequent service, CAL Overhaul Foreman Durham's invention permits rear impeller shaft bearing cage to be removed in 15 min. as against 6 hr. formerly required.



BATTERY CART MAY BE TOWED OR PUSHED

● Carrying two large batteries and equipped with both snow and Pyrene extinguishers, AA's rubber-tired unit is designed to be used either as trailer or pushcart. Light weight and ease of handling permit it to be taken to any place on apron or in hangar, while its compact construction enables it to be moved where larger equipment could not go.



COUNTER MEASURES AND RECORDS ROLLED MATERIALS

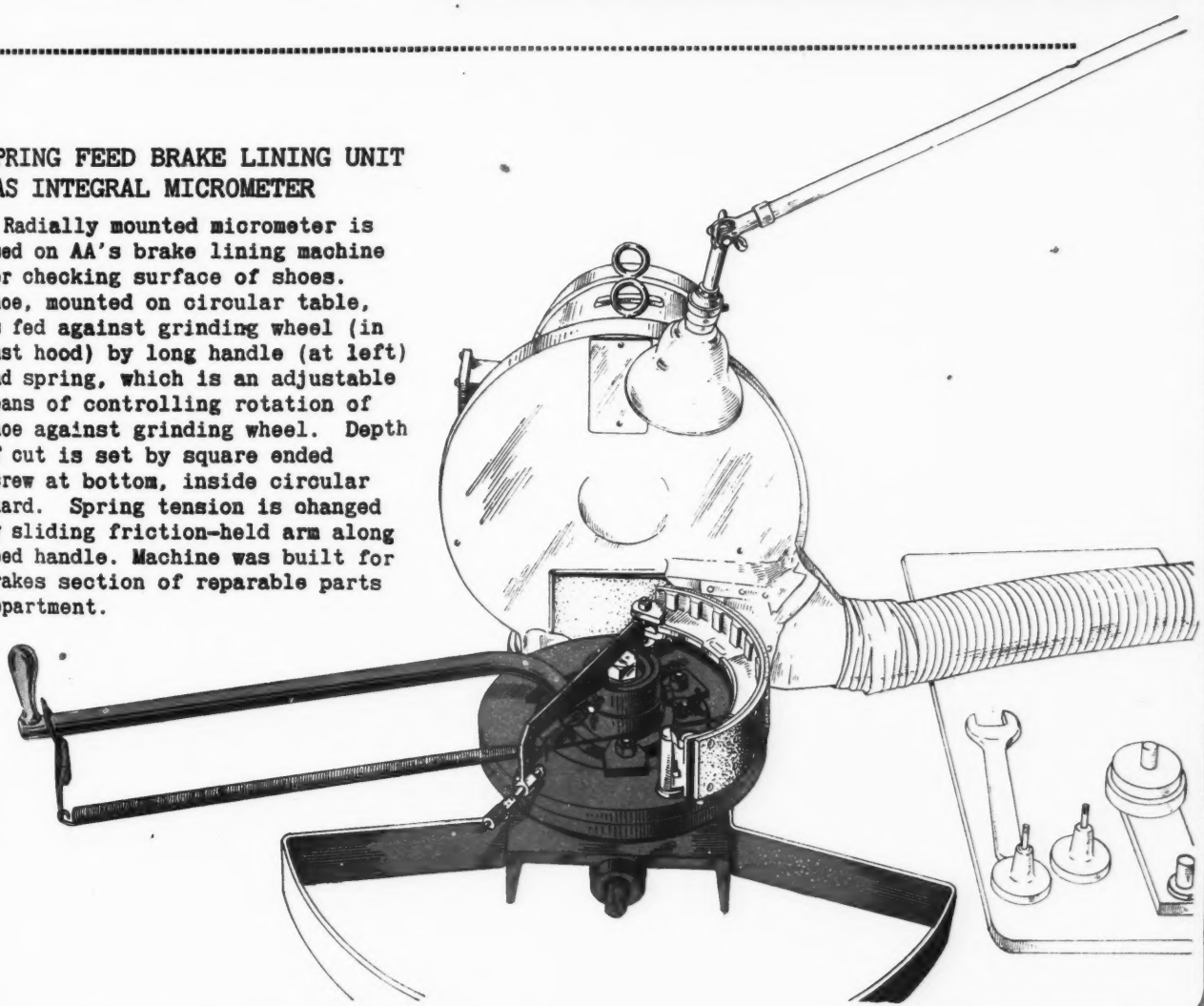
● For measuring odd lengths of any kind of rolled material and totalling the amount taken from the roll, this simple adaptation of a standard counter is useful in either stock or drafting room. Rubber roller on end of counter is pressed onto surface of roll by spring action, thus recording the length of material passing beneath it.

"SAFETY FIRST" IS IDEA BEHIND RADIATOR RACK

To do away with risk of damage to extremely light material used in oil radiators, this rack, with individual cradles for units, was built by AA's engine installation welding shop. Since installation of this rack, no damage while in storage has occurred.

SPRING FEED BRAKE LINING UNIT HAS INTEGRAL MICROMETER

Radially mounted micrometer is used on AA's brake lining machine for checking surface of shoes. Shoe, mounted on circular table, is fed against grinding wheel (in dust hood) by long handle (at left) and spring, which is an adjustable means of controlling rotation of shoe against grinding wheel. Depth of cut is set by square ended screw at bottom, inside circular guard. Spring tension is changed by sliding friction-held arm along feed handle. Machine was built for brakes section of reparable parts department.

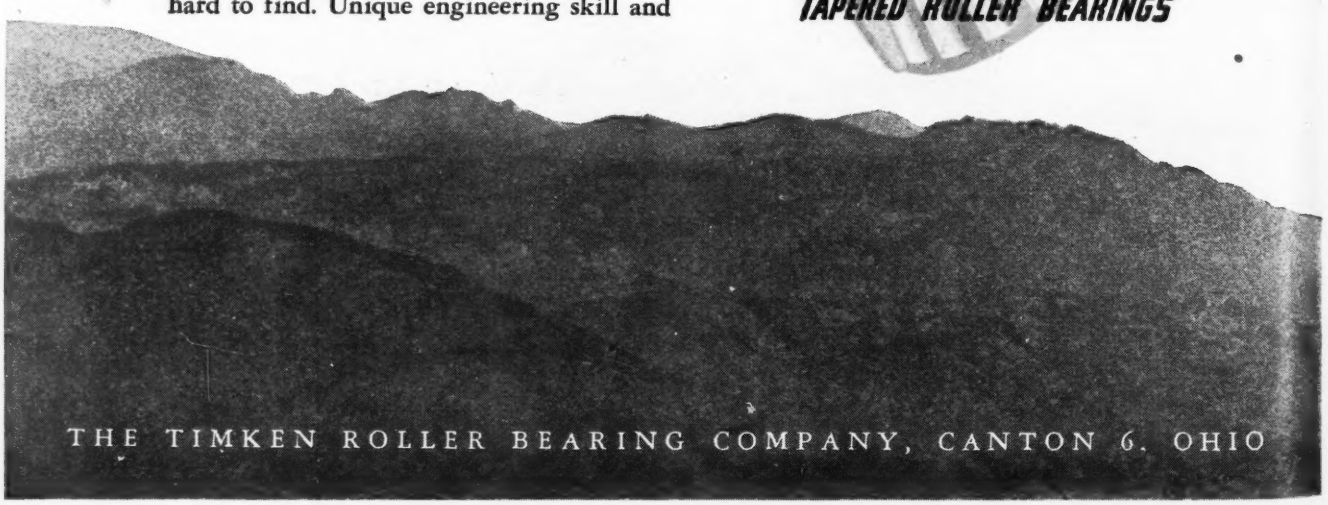


Nearing the speed of Sound with TIMKEN BEARINGS

When the world's fastest airplane, the P-80 Shooting Star zooms into space, it comes closer to the speed of sound than any plane ever built.

And when it returns to earth again, it settles down as safely and surely as possible on landing wheels equipped with the world's best — matchless bearings made by Timken.

The reasons for this pre-eminence are not hard to find. Unique engineering skill and experience, the most precise manufacturing methods, and unexcelled Timken Electric Furnace Alloy Steel are only three of them —and there are many more. Our engineers will be glad to give you full details and make specific recommendations to meet your need. Why not write?



THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

Construction and Operation Of New Injection Carburetor

Revealing for the first time complete engineering details—together with operating technique—of new Stromberg small-plane injection carburetor designed for efficient performance in any position.

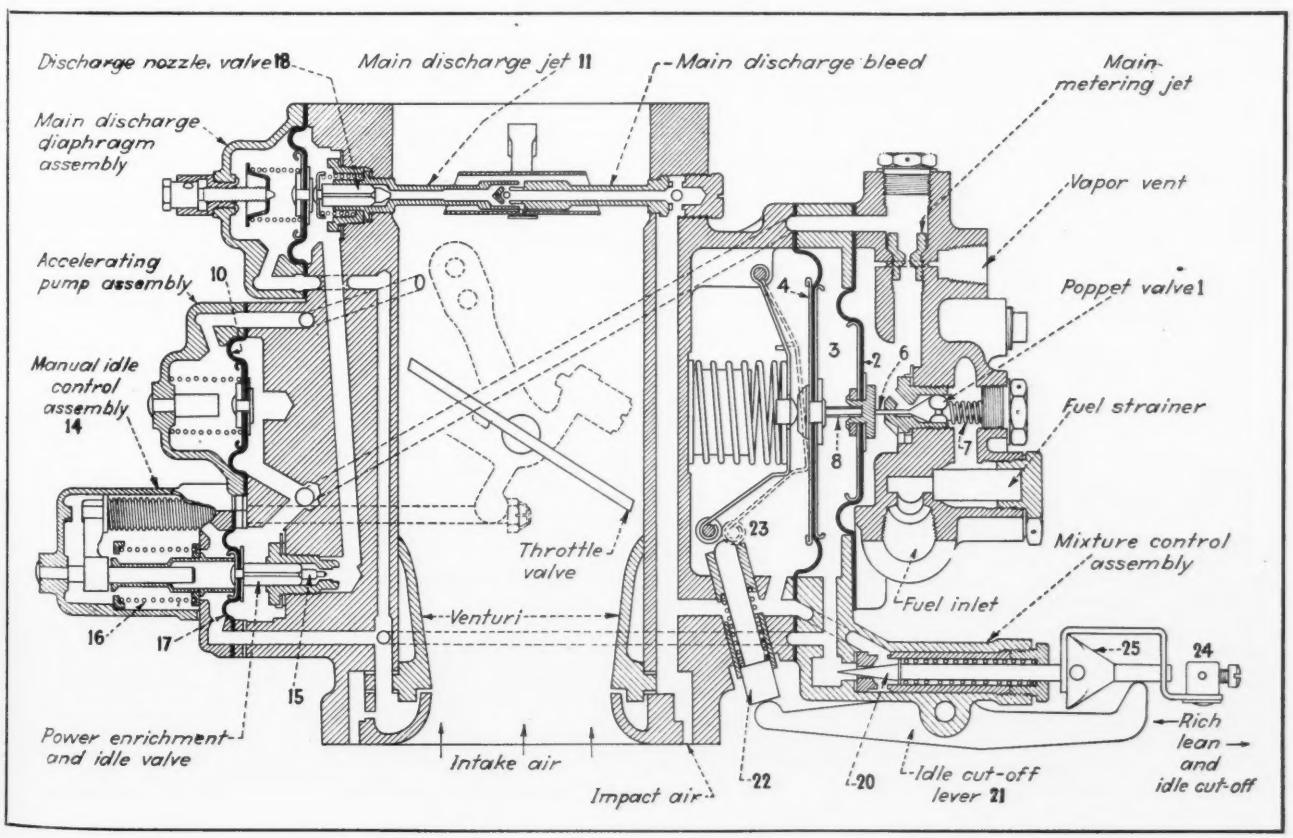
STROMBERG "PS" series single barrel injection carburetors are of the injection type and operate independently of gravity; thus they can be installed in any position—updraft, downdraft or horizontal.

Fuel flow is regulated by pressure on a diaphragm and not by a float, therefore, as in most modern carburetors, a pressure of 12 psi. plus or minus 1 lb. is required in the fuel line to insure adequate flow. As fuel flow is dependent only on pressure, control lever should always be moved into *idle cut-off* position when engine is stopped, as this is the only position where fuel flow is cut off. In any other throttle position fuel will flow constantly and either the engine or carburetor air passage will be flooded in a short time. Moving the throttle lever back and forth rapidly will not prime the engine as the acceleration pump does not fill unless throttle is closed while engine is running and several seconds are required for the fuel to fill the chamber.

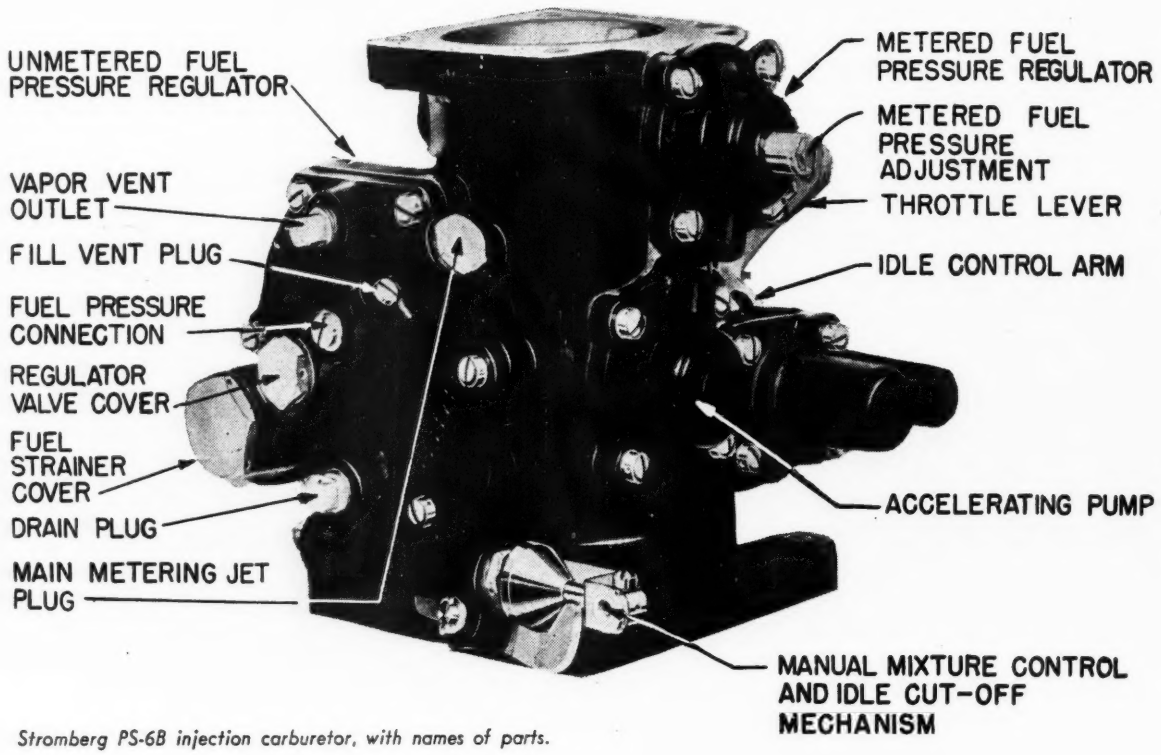
The carburetor consists of several units, each of which has its own function to perform. The fuel metering system admits fuel, strains it and regulates its pressure; the main metering jet meters the fuel; idle control and power enrichment regulates flow of fuel in proportion to volume of air flowing through venturi; discharge diaphragm and valve regulate pressure of metered fuel to main discharge jet, by means of venturi pressure and fuel pressure acting against one another, together with spring action; accelerating pump momentarily provides extra fuel when throttle is opened suddenly, being operated by a spring acting against suction above throttle.

As is shown in the schematic cross section, fuel enters through poppet valve (1) controlled by diaphragm (2) on other side of which is venturi pressure (suction). Chamber (3) between this diaphragm and the large one (4) on left is connected directly to main venturi so that pressure varies with venturi suction. Left side of diaphragm (4) is connected to intake air and has same pressure as the air entering carburetor. This diaphragm has a spring behind it which operates in the same direction as atmospheric pressure, augmenting its action. At idle shut-off this spring is locked in a compressed condition by action of idle plunger (22) as will be described later.

Poppet valve (1) action is governed by stem (6) bearing on center of dia-



Schematic cross section of carburetor.



Stromberg PS-6B injection carburetor, with names of parts.

phragm. The valve is closed by spring (7). When fuel pressure on diaphragm (2) exceeds that between diaphragms in space (3), diaphragm (2) moves to the left as far as is permitted by the pin (8) extending between the diaphragms and fastened to (4). This permits the poppet valve to close and shut off the flow of fuel from the line.

As venturi pressure is reduced by increased suction due to opening throttle (9) pressure between the diaphragms is also lowered and movement of the larger diaphragm (4) to the right, due to spring and atmospheric pressure, causes the poppet valve to open and admit fuel until the pressure of the fuel closes, or partly closes, the poppet though action of the smaller diaphragm (2). In this manner, fuel pressure is kept approximately constant with regard to pressure of air passing through venturi, tending to keep the mixture constant as long as other conditions are not changed.

If the throttle is opened suddenly, there is—in any carburetor not designed to overcome the condition—a momentary lag of fuel flow, as compared to the air, due to greater viscosity and inertia of the former. This results in an over-lean mixture at the time when full rich is required, causing backfiring into the manifold and carburetor.

To counteract this the accelerating pump is fitted. It consists of a diaphragm (10) on left of which is manifold suction pressure through passage above the throttle. This pressure varies with throttle opening, causing a pumping action when the throttle is moved. Closing the throttle causes a strong suction at the left of the diaphragm, drawing it in that direction, compressing the spring, and filling the right hand chamber with fuel.

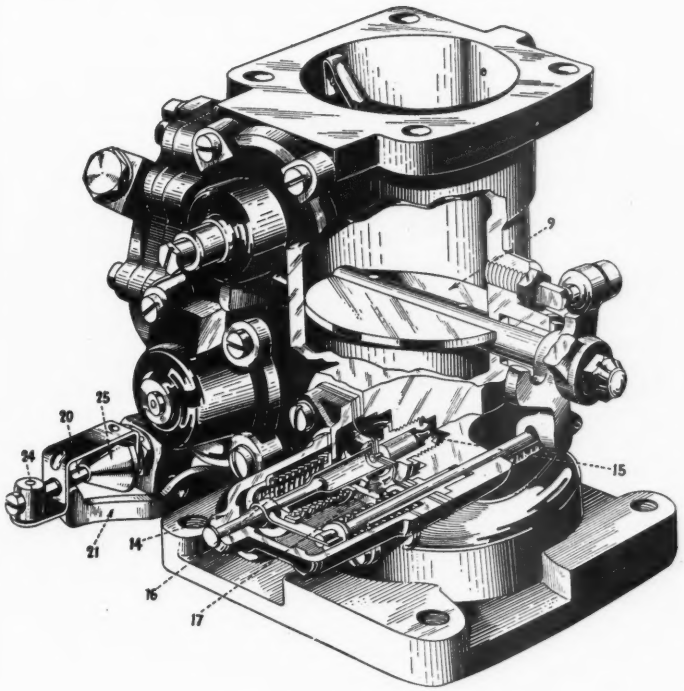
As long as the throttle remains in approximately the same position the chamber retains its charge of fuel. If however, the throttle is suddenly opened, the suction above it is lessened, the same happening in the space behind the diaphragm. As there is then no force compressing the spring, it forces the diaphragm to the left, discharging extra fuel into the passages which supply the main discharge jet, automatically providing the full rich mixture needed for acceleration.

To provide for better atomization of the fuel, an air bleed is provided which mixes bubbles of air with the fuel before it emerges from the jet, causing it to leave in the form of foam rather than in solid globules. By the time the acceleration pump is empty, regular flow of fuel has been established and the pump remains empty until the diaphragm is again drawn to the right by suction caused by closing the throttle. From this it will be seen that "pumping" the throttle will not result in priming the engine as the chamber will neither fill nor empty, due to time being required for either process.

On its way from the right side of the carburetor to main discharge jet (11) fuel passes into idle control (14) through a valve (15) connected to throttle lever as shown by dotted lines. Idle valve is operated by diaphragm (17) controlled from throttle lever and operated by spring (16) and venturi and fuel pressure. Increased fuel pressure tends to open valve (15) and increases flow as does increased venturi suction due to greater throttle opening, while decreased suction, due to closing throttle, allows spring (16) to move diaphragm to right and close valve (15) shutting off flow of fuel to main jet.

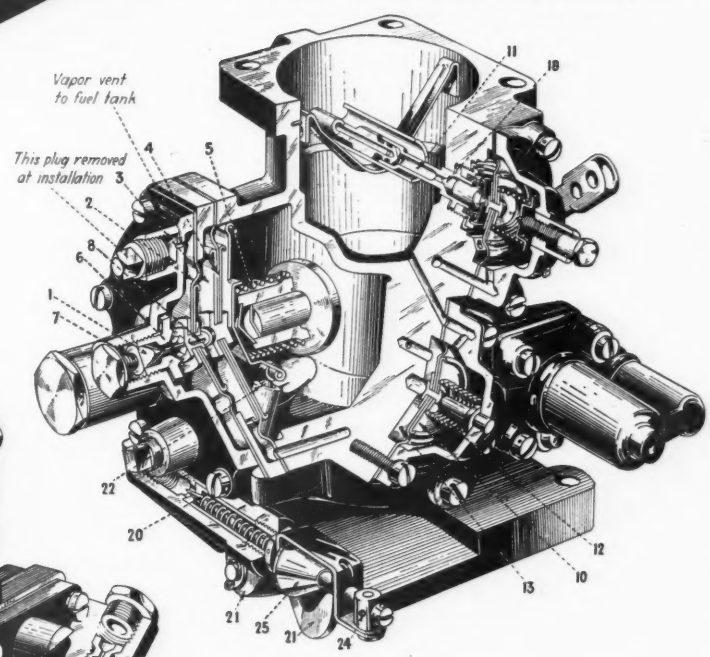
Sudden acceleration results in increased fuel pressure on diaphragm (17) due to action of accelerating pump which forces fuel into the chamber behind the valve, moves diaphragm to left and opens the valve, permitting an increased flow to main jet, (11) thus compensating for the increased air flow which originally caused it.

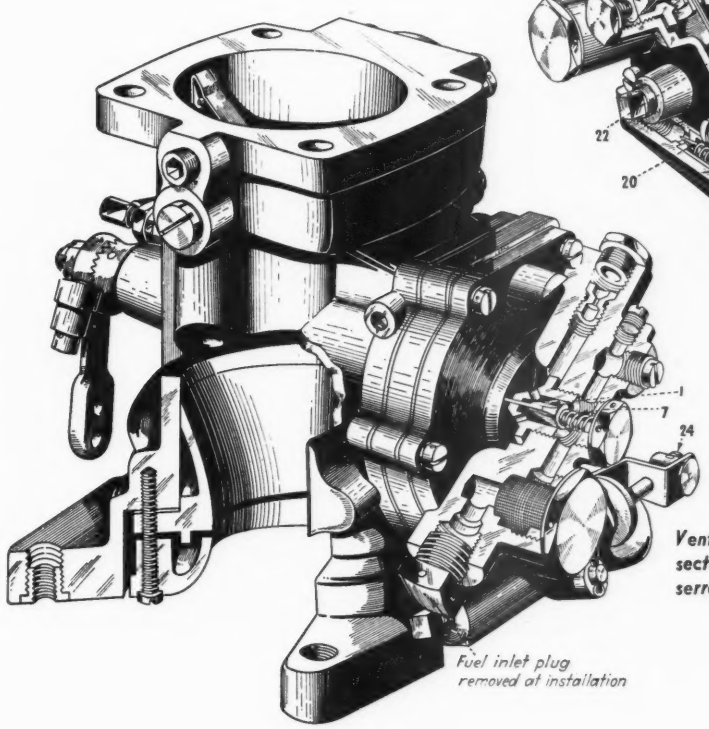
Discharge nozzle valve (18) regulates the pressure of the metered fuel flowing to main discharge jet (11). On left of valve is spring pressure tending to close it against venturi suction which acts counter to the spring. On right is fuel pressure regulated by idle valve (15). When fuel pressure exceeds 3 psi. valve (18) opens and passes fuel to main discharge jet, the amount of opening varying with the ratio of fuel pressure to venturi suction and adjust-



Part section through throttle and idle manual control. Numbers are those referred to in text.

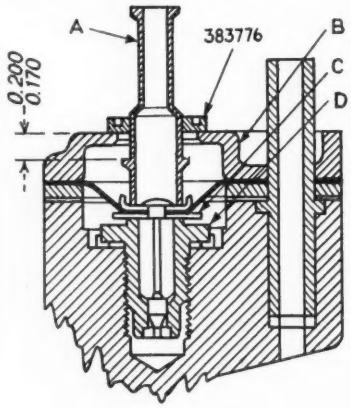
Quarter section with fuel metering and diaphragms at left, mixture control below. At right are discharge nozzle and diaphragm (top) and accelerating pump (bottom).



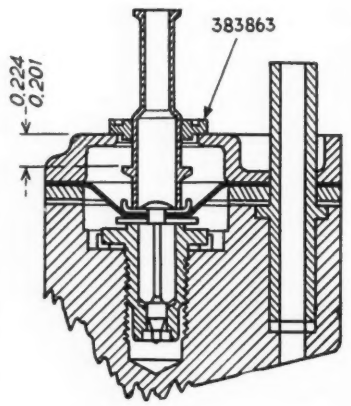


Venturi and fuel admission system in part section. At center left is throttle arm with serrated adjustment in 15 deg. steps.

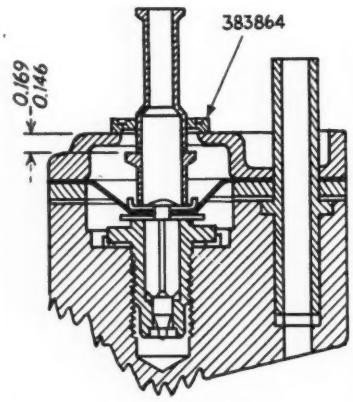
Hold down plunger "A", so diaphragm washer "C" is against seat "D" as shown.



If dimension from face of cover "B" to shoulder of plunger "A" gages 0.200/0.170, assemble 383776 washer.



If dimension gages 0.224/0.201, assemble 383863 washer.



If dimension gages 0.169/0.146, assemble 383864 washer.

ment of spring behind the diaphragm.

At the idle cut-off the mixture control valve (20) at lower right is opened by movement of control rod (24) connected to it, permitting atmospheric pressure to fill space (3) between diaphragms (2) and (4). As action of spring behind (4) is locked at (23) by action of plunger (22), which is moved by idle cut-off lever (21) and sliding cam (25), this atmospheric pressure moves diaphragm (4) to left, whereupon spring (7) behind poppet valve, aided by fuel pressure on (2), causes valve stem (6) to move (2) to left, allowing valve to close, shutting off flow of fuel but leaving carburetor full.

As metered fuel pressure immediately drops to less than 3 psi. valve (18) also closes and the contents of the carburetor are sealed until throttle is again opened. Vapor vent at main metering jet is connected to tank to remove air or vapor trapped in fuel, but the opening—No. 70 drill—is too small to cause leakage as all internal valves are closed when engine is not running.

As the opening of poppet valve (1) depends to a large extent upon the position of the large diaphragm (4) it naturally follows that fuel flow depends upon the difference of pressure between the two sides of the diaphragm. With mixture control valve (20) closed these are atmospheric on left and venturi suction on right, becoming more and more equal as air flow is permitted between the two sides by opening the mixture control valve. Hence, opening the mixture control valve (20) affects the richness of the mixture by governing fuel flow and pressure through the position of the poppet valve operated by the diaphragms, while increasing the pressure behind the diaphragms which close the idle control and discharge nozzle valves, thus decreasing the resistance against the springs which tend to close them.

Installation

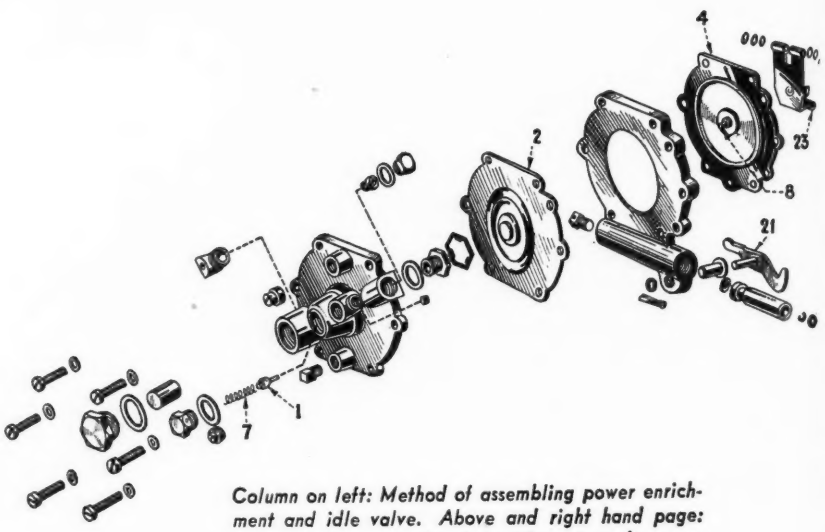
Attach vapor return line between carburetor and tank; connect fuel line, using $\frac{1}{4}$ PT connections and $\frac{1}{8}$ PT connections for pressure gage.

Throttle should be adjusted so that it has a full range of movement from full open to full closed. The outside adjustment has variations of 15 deg. to allow of this being done. Connect manual mixture and idle cut-off mechanism to controls, using No. 45 drill size connection.

Fill carburetor in following manner: open fuel valve at tank. Set mixture control at full rich. Open throttle. Operate wobble pump until pressure is not less than 5 psi. and continue until fuel runs from nozzle. If carburetor appears air-locked or fuel does not flow evenly, or if engine stops after starting —later—remove *Fill Vent Plug* and work wobble until fuel reaches level of vent opening. Replace plug.

Starting

With primer. Set mixture control at *Idle Cut-Off* and throttle at about 1,200 rpm. Operate wobble pump to supply primer with fuel and then give two or three strokes of primer. Sometimes a very cold engine may require more, but



Column on left: Method of assembling power enrichment and idle valve. Above and right hand page: Exploded view of carburetor, with part numbers corresponding to those in other drawings and in text.

care should be taken not to overprime and flood engine. Work wobble pump until fuel pressure is 5 psi. Turn on ignition switch. Engage starter and move mixture control to *Full Rich* when engine starts. If engine stops, move control *immediately to Idle Cut-Off* to prevent flooding. Operate wobble pump until engine-driven pump brings fuel pressure to normal.

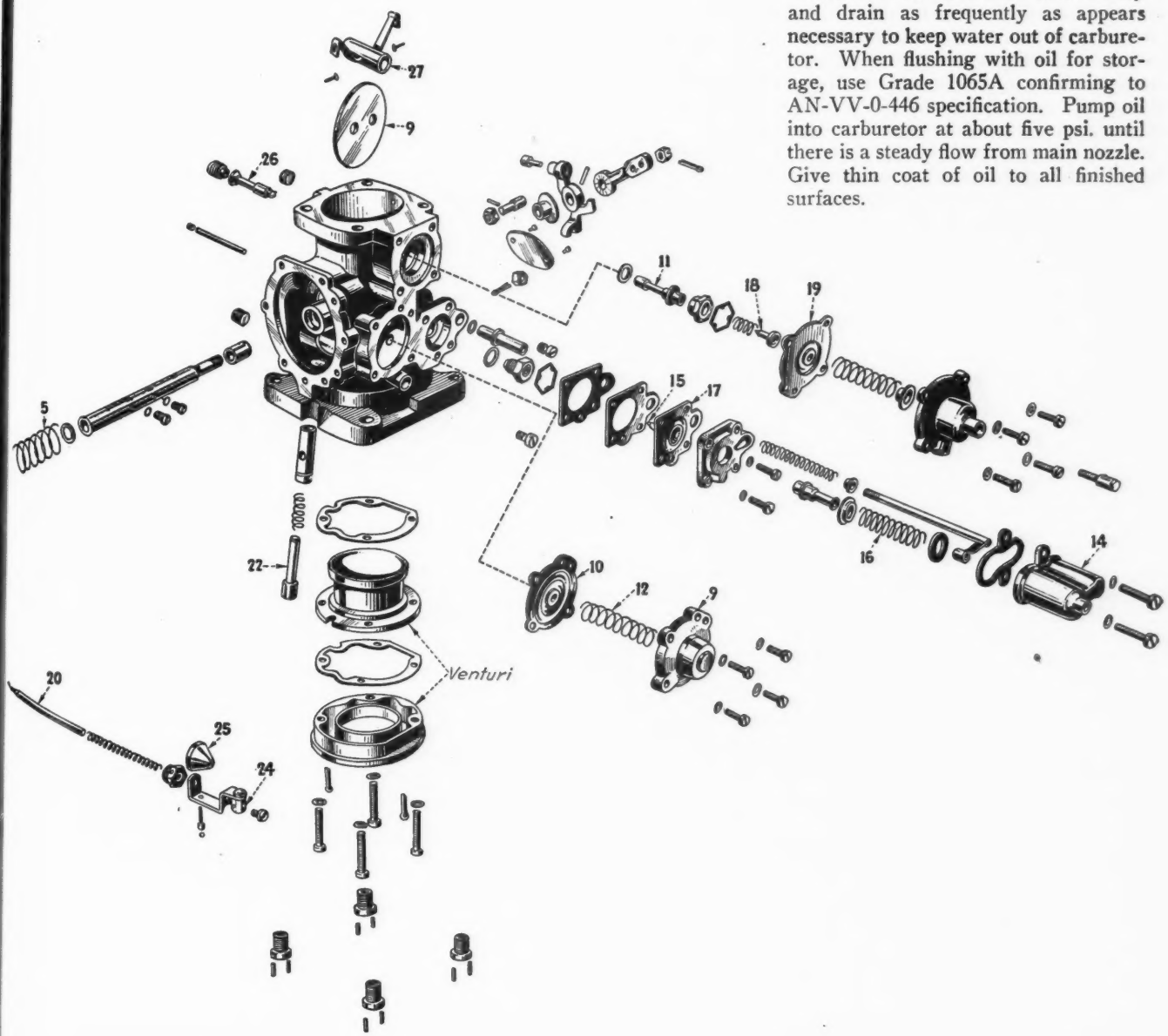
Without primer. Place mixture control at *Idle Cut-Off*. Operates wobble pump until fuel pressure rises to five psi. Turn on ignition switch. Engage starter. When engine starts move mixture control to *Full Rich* and work wobble pump until engine fuel pump takes over and build up pressure to specified amount. Be sure to move control back to *Idle Cut-Off* whenever engine is stopped. If engine is cranked by hand to clear it, in case of flooding, *always shut off ignition, otherwise a serious accident may occur.*

Metered fuel pressure adjustment is made by turning adjusting screw not more than 1/6 turn at a time until *maximum* engine speed with *minimum* manifold pressure throttle being first set between 1,200 and 1,500 rpm. before starting adjustment. Turning screw clockwise gives leaner, and counter-clockwise, richer mixture. *Idle speed* adjustment should be set to give minimum engine rpm. specified by manufacturer. *Idle mixture* adjustment should always be made on an engine at idling heat, that is, after idling at about 800 rpm. for five minutes. After idling speed adjustment has been first obtained, run engine to clear it out. Close throttle and note rpm. and manifold pressure. Turn idle mixture adjustment 1/6 turn at a time in either direction until change in rpm. is noted without moving throttle. Install cotter pin in PS-6 models after each change to prevent nut from turning. Run engine to clear it out, then idle for half minute. Take rpm. and manifold pressure readings and compare with the previous ones. If engine speed has increased and manifold pressure decreased, adjustment was in wrong direction and should be reversed. After satisfactory results are obtained, metered fuel adjustment should be rechecked at 1,500 rpm. If this requires readjustment, then the other adjustments made previously will also need to be checked again.

Under no circumstances should idle control be leaned below maximum engine idling speed as carburetor setting in this case would be such that poor acceleration would result. If this tendency is noted, metered fuel pressure adjustment could be moved one notch at a time in counter-clockwise direction until correct results are obtained.

To stop engine, place mixture control in *Idle Cut-Off* position and leave that way until starting again. Shut off ignition after engine has stopped.

Remove and clean fuel strainer daily and drain as frequently as appears necessary to keep water out of carburetor. When flushing with oil for storage, use Grade 1065A confirming to AN-VV-0-446 specification. Pump oil into carburetor at about five psi. until there is a steady flow from main nozzle. Give thin coat of oil to all finished surfaces.



ANALYZING THE ASPECTS OF FUTURE FLIGHT

PART II

By C. E. PAPPAS, *Chief of Aerodynamics, and*
M. G. HARRISON, *Aerodynamics Mathematics Consultant, Republic Aviation Corp.*

Concluding this investigation of high-altitude high-speed operation, details are presented concerning supersonic flow, hp. required, and extreme-height atmospheric conditions.

IT HAS BEEN STATED that at a Mach number between 0.85 and 1.2, an aircraft will, in all probability, experience severe buffeting from unsteady airflow conditions. The next logical step would then be to fly above Mach numbers of 1.2, where the airflow will again become steady. However, it is important to realize that some design precautions are still necessary even though we expect to fly in the steady-state flow condition. Since the wing ends abruptly at the tip, a very highly disturbed flow occurs there within a conical region known as the Mach wing tip cone. The wing would have to be so designed and located that the influence of this cone, when extended, did not fall within the location of the tail surfaces, to avoid serious interference effects.

To show the streamline picture of the y- and the z- velocity components in the plane $x = 2t$ (t = chord) at right angles to the axis of the Mach cone, Fig. 7 has been plotted.[7] The wing considered is rectangular in plan form assuming a constant lift distribution. The streamline picture behind the wing has, outside the Mach cones arising from the wing tips, a constant downwash velocity because of the plane waves in two strips symmetrical to the plane $z = 0$. These two strips are limited by the plane waves starting from the forward and trailing edges of the lifting surface, and the induced velocities become infinite on the cone surface. On the cone axis the x-component of velocity is zero but the y- and the z- components become infinite as $1/r$ (where r is distance from axis of the cone).

[7]All references are collated at end of this article, page 162.

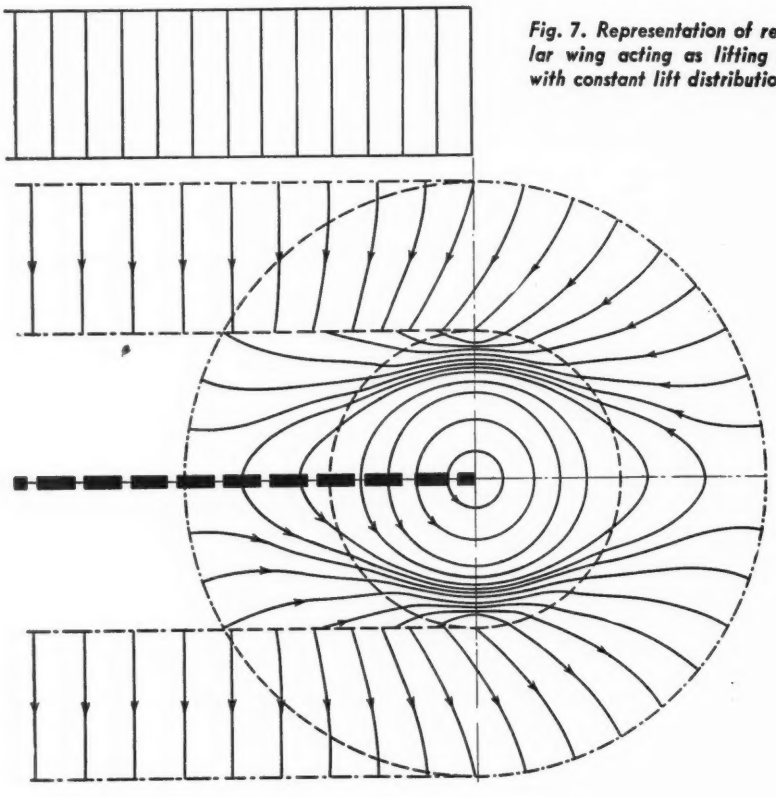


Fig. 7. Representation of rectangular wing acting as lifting surface with constant lift distribution.

Since a wing tip Mach cone exists in a supersonic flow, the tip should have a plan form taper so that the Mach cone at the tip of the leading edge does not cut the wing, as shown in Fig. 8. Thus, the induced drag is zero and only the drag resulting from wave resistance exists.

Also, there is zero downflow in the entire space outside the two wing tip Mach cones and the two strips formed by plane waves starting from forward and trailing edges of the lifting surface, as can be seen in Fig. 7. Experimental verification of this fact can be seen in Ferri's work[8] concerned with three different airfoil sections tested at angles of attack varying from −12 to 12 deg. at Mach numbers of 1.85 and 2.13, and wherein it is photographically demonstrated that the wake is actually undeflected.

Considering the foregoing streamline pattern, it is apparent that great care should be exercised in the location of the conventional tail surfaces with respect to the disturbed regions arising from the two tip Mach cones.

Attainment of high speeds in an atmosphere is contingent upon the production of the very high hp. required to propel the plane. If we assume a fuselage 6 ft. in dia., approximately 12,000 hp. will be required at a Mach number of 2.0 and at 50,000 ft.—a value obtained by assuming that the drag is similar to that of a bullet. However, the wake resistance, for a projectile such as a bullet, will not exist when the tail end is faired to a smooth point such as in a well-streamlined fuselage body. On this basis, the drag will be composed of head resistance and skin friction. The value of C_D given in von Karman & Moore[9], is then approximately twice the value a well-streamlined tail-end projectile would have. Assuming a wing loading of 100 lb. per sq. ft., the hp. required for a wing area of 300 sq. ft. will be 15,000 hp. at Mach 2 and at 50,000 ft. Compatible with this 15,000 hp. is an airfoil whose cross-section is like an isoceles triangle having a horizontal bottom with 7 deg. leading and trailing edge angles—an airfoil corresponding to the G. U. 4 section in Ferri's work[8], and having

the least drag of all the sections covered in the report. This corresponds to a 6% airfoil thickness. Assuming the empennage to be 33% of the main wing area, the hp. required for the tail surface group would then be 5,000. If interference effects are allowed for, the total hp. required would be about 35,000 to 40,000.

Since high speeds in dense low atmosphere are attended by intense heating and high drag, it may be necessary to fly at great altitudes when very high speeds are attempted. And because atmosphere at the height contemplated is practically non-existent, there will be no probability of achieving lift in the conventional manner. Hence it becomes logical to consider the possibility of projectile flight—with the airplane attaining a high velocity during its passage through the lower atmosphere and then continuing as a free body, possibly assisted by rockets, in an elliptical orbit until it again intersects the earth's atmosphere and takes on the character of a conventional airplane.

Proceeding on this basis, the minimum velocities and energies required for projectile flight to various distances on a "stationary" earth were calculated and are as plotted in Figs. 9 and 10. The effect of the rotation of the earth can be conveniently divided into two parts. First is the effect on the initial velocity of the projectile. Since the maximum speed of the earth is about 1,000 mph. at the equator, the effect of the earth's speed will be a small fraction of the projectile speeds. (Fig 9). The second effect is produced by the rotation of the earth during the time of flight. For the longest flight—about $\frac{3}{4}$ hr. (12,500 mi. at 17,800 mph.), the earth will turn $\frac{3}{4} \times 1{,}000 = 750$ mi. at the equator. This distance is a small part of the total flight. Hence it is, concluded that while the earth's rotation will have to be considered in calculating correct flight paths, the requirements for velocity and energy given by Figs. 9 and 10 are substantially correct. Fig. 11 shows the actual flight paths plotted in relation to the earth.

Calculation of the flight paths is as follows: The earth is replaced by a force acting at its center, and the projectile describes an elliptical orbit with this force-point at one focus of the ellipse. The energy of the projectile in this orbit consists of potential energy of the gravitational field and kinetic energy of the moving projectile. Referring to Fig. 12, point A is the center of force at the focus of the ellipse at a distance c from the center of the ellipse, a is the semi-major axis of the ellipse, b the semi-minor axis, P the peak of the orbit, r the radius of the earth, m

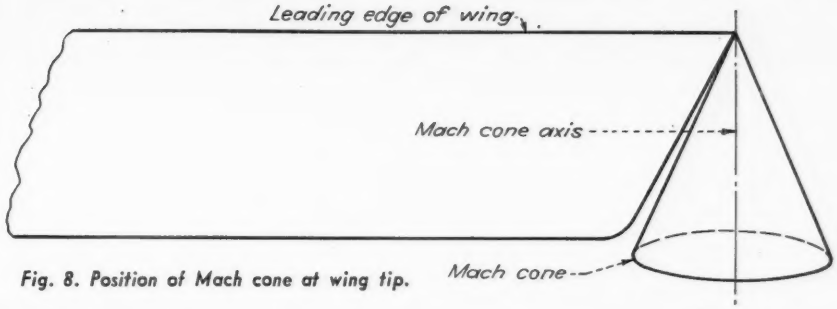


Fig. 8. Position of Mach cone at wing tip.

the mass of the projectile, and V_P the velocity in the orbit at P.

At P the velocity must be such as will produce a centrifugal force which just balances the attraction of the earth. Since the radius of curvature of the ellipse at P is b^2/a, and the attraction of the earth varies as the inverse square of the distance, we obtain:

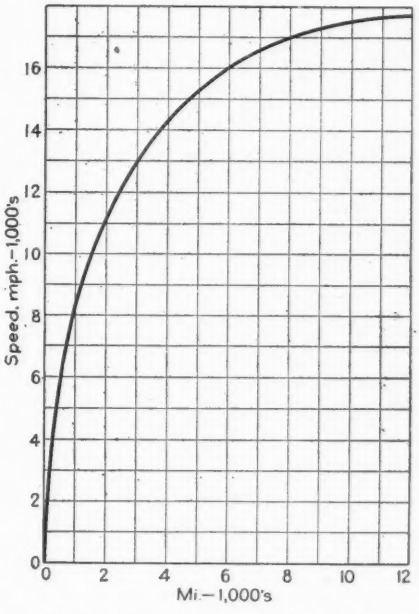


Fig. 9. Initial speed required for trajectory flight on surface of earth plotted against distance traveled.

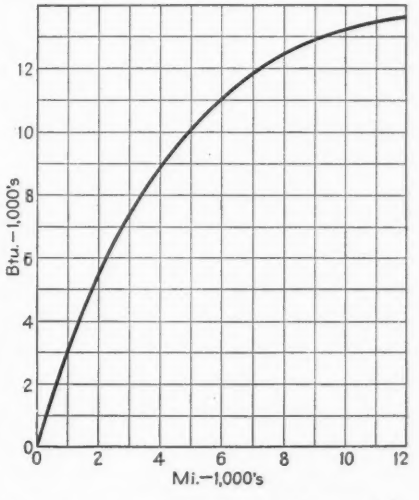


Fig. 10. Btu. per pound of airplane weight, required for trajectory flight on surface of earth, plotted against distance traveled.

$$mg\frac{r^2}{(a+c)^2} = \frac{mV_P^2}{b^2/a}$$

The kinetic energy at P is thus

$$1/2\, mV_P^2 = \frac{mg}{2}\frac{b^2}{a}\frac{r^2}{(a+c)^2}$$

The potential energy with reference to the energy at infinity is

$$-mg\frac{r^2}{a+c}$$

Hence, the total energy of the particle p with reference to the energy level at infinity is

$$\frac{mg}{2}\frac{b^2}{a}\frac{r^2}{(a+c)^2} - mg\frac{r^2}{a+c}$$

The energy at the surface of the earth is all potential and equals $-mgr$. Therefore, the total energy (H) must be increased by

$$mgr\left[\frac{b^2}{(a+c)^2}\left(\frac{r}{2a}\right) - \frac{r}{a+c} + 1\right]$$

so as to travel in the given orbit.

This expression reduces as follows:

$$H = mgr\left[r\left(\frac{b^2 - 2a\,(a+c)}{2a\,(a+c)^2}\right) + 1\right]$$

$$= mgr\left[r\left(\frac{b^2 - 2a^2 - 2ac}{2a\,(a+c)^2}\right) + 1\right]$$

But $c^2 = a^2 - b^2$, and therefore,

$$H = mgr\left(1 - \frac{r}{2a}\right) \qquad (1)$$

Hence, for this required energy to be minimum, "a" must be as large as possible, subject to the condition that the orbit goes through the desired initial and final points. In Fig. 13, r is the radius of the earth, θ is half the angle subtended by the total flight path, and x and y are cartesian coordinates.

The equation of the ellipse with focus at A is

$$\frac{(x-c)^2}{a^2} + \frac{y^2}{b^2} = 1$$

Or in terms of r and θ,

$$\frac{(r\cos\theta - c)^2}{a^2} + \frac{r^2\sin^2\theta}{b^2} = 1$$

Substituting $b^2 = a^2 - c^2$ and solving for a^2/r^2,

$$\frac{a^2}{r^2} = \left[2\,\frac{c}{r}\left(\frac{c}{r} - \cos\theta\right) + 1 \pm \sqrt{4\,\frac{c}{r}\left(\frac{c}{r} - \cos\theta\right) + 1}\right]/2$$

Differentiating with respect to c/r,

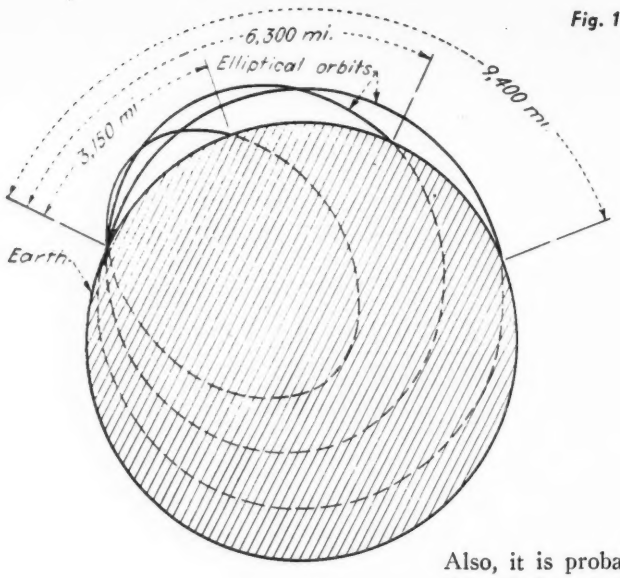
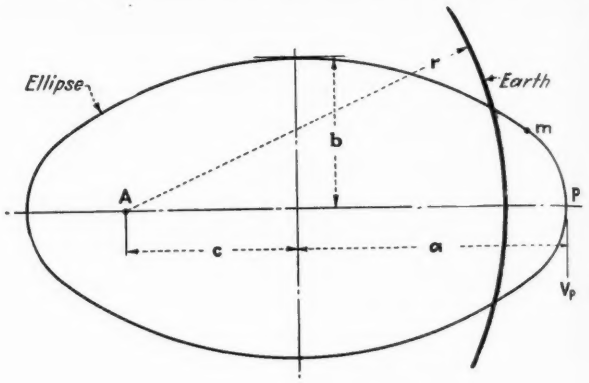


Fig. 11 (left). Diagram showing minimum energy trajectories for projectile flight.

Fig. 12 (below). Elliptical orbit of projectile flight with respect to earth.



$$\frac{d\left(\frac{a^2}{r^2}\right)}{d\left(\frac{c}{r}\right)} = (2\,\frac{c}{r} - \cos\theta)$$

$$\frac{\sqrt{4\,\frac{c}{r}\left(\frac{c}{r} - \cos\theta\right) + 1} \pm 1}{\sqrt{4\,\frac{c}{r}\left(\frac{c}{r} - \cos\theta\right) + 1}}$$

Setting the derivative equal to zero,

$$c = \frac{r\cos\theta}{2}$$

which when substituted in equation 2 gives

$$a = \frac{r}{2}(1 + \sin\theta)$$

Putting this value in Eq. 1 for the required energy,

$$H = mgr\left(\frac{\sin\theta}{1 + \sin\theta}\right)$$

The initial velocity (V) is found from the condition:

$$\frac{1}{2}mV^2 = H = mgr\left(\frac{\sin\theta}{1 + \sin\theta}\right)$$

or

$$V = \sqrt{2gr\left(\frac{\sin\theta}{1 + \sin\theta}\right)}$$

The maximum altitude is $a + c - r$ or $r/2(\cos\theta + 1 + \sin\theta - 2)$, or $r/2(\cos\theta - 1 + \sin\theta)$.

Atmospheric Conditions

Pressure, density, and temperature: Since flight at extreme altitudes is contemplated, it is interesting to make a study of ambient conditions at these heights. The interesting phenomena include factors of pressure, density, temperature, composition of atmosphere, presence of ions and meteoric dust, and electric charge on a body at these altitudes.

According to Humphreys,[10] the temperature rises irregularly to extreme altitudes, as shown in Fig. 14. Also, it is probable that the composition of the atmosphere is still largely oxygen and nitrogen. Assuming that this is a reasonably correct, the pressure and density of the air may be calculated as follows:

Pressure (p) decreases with an increment of altitude by exactly the weight of the column of air included by a cylinder of unit base area and height equal to the altitude increment. Thus,

$$dp = -\rho g\,dh$$

However, according to the gas law,

$$p/\rho = R\,T$$

where R may be determined by substituting P, ρ, and T at any known altitude.

Hence,

$$\frac{dp}{p} = -\frac{g}{RT}dh$$

From the curve of Fig. 14, g/RT may be expressed as a function of h.

Therefore,

$$\log\frac{p_2}{p_1} = \int_{h_1}^{h_2} -\frac{g}{RT}dh$$

$$-\int_{h_1}^{h_2}\frac{g}{RT}dh$$

or $p_2 = p_1\,e$

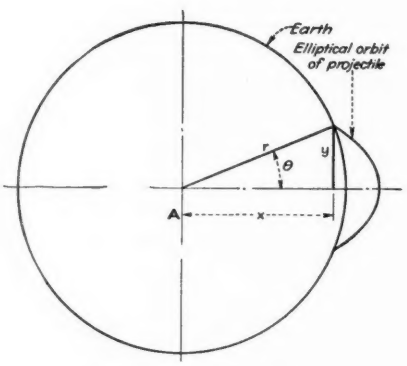


Fig. 13. Diagram showing elliptical orbit of projectile

Using this equation and the gas law, the curves of Figs. 15 and 16. were determined for pressure and density at extreme altitudes. Results are given in the form of σ's or ratios of pressure and density to their sea level values.

Heating of surface of body by means of recombination of ions at surface of body: Since it is well known from the theory of radio transmission that the upper air is ionized, it is interesting to investigate the possibility of heating by means of the recombination of ions on the surface of the body or projectile. But a short calculation readily convinces one that the effect is negligible.

According to Pender and McIlwain,[11] the maximum density of ions in the various layers probably does not exceed 10^6 per c.c. at any time of day. If 20 electron v. were liberated at each recombination, and if a recombination occurred for every ion so lying that the path of the projectile eventually intersected its position, the energy liberated per sec. at 3,000 m.p.s. on a body with a cross-section of 4 sq. m. would be

$$10^6\,(4 \times 10^4) \times 3 \times 10^5 \times 20 \times 1.6 \times 10^{-19}$$
$$= 0.384 \text{ joules per sec.}$$

where 1.6×10^{-19} is the number of joules per electron v.

This quantity of heat is entirely negligible.

Heating of surface of body as result of storage of electrical energy at surface of body: Finally, it should be considered that the body will become charged at these high altitudes. Humphreys[10] estimates the difference of potential (E) at high altitudes to be 1,000,000 v.

For a body of 900 cm. (30 ft.) long, the capacity (C) will be approximately (see Ref. 12),

$$C = .4 \times 900 \times 10^{-12} \text{ farads.}$$

The energy storage is

$$1/2\,C\,E^2 = 1/2 \times .4 \times 900 \times 10^{-12} \times (10^6)^2$$
$$= 1.8 \times 10^4 \text{ watt sec.}$$

which is deemed a negligible amount.

Temperature of black body in proximity to the earth, when subjected to sun's rays: The ability of a given substance to emit radiation when heated, is proportional to its ability to absorb radiation. Denoting the emissivity and absorption by I and A respectively,

$I = sA$, where s is a constant.

When absorption is complete, A is unity and $I = s$. Under these conditions, the constant may be defined as the emissivity of a body which absorbs all the incident radiation and reflects none. Such a body is called a black body or perfect radiator.

Total radiation from a perfect radiator is directly proportional to the fourth power of the absolute temperature. If the total radiation is denoted by R_t we may state $R_t = \lambda T^4$, where λ is a constant and as such is equal to 5.709×10^{-5} erg cm.$^{-2}$ sec.$^{-1}$ deg.$^{-4}$ or 8.22×10^{-11} cal. cm.$^{-2}$ min.$^{-1}$ deg.$^{-4}$ (Ref. 13).

The temperature of a body placed in a radiant energy field is determined by means of a heat balance between the energy impinging on the body and the energy it re-radiates. Energy impinging on a body in the region of the earth comes from the earth and the sun. Energy from the sun is 1.94 cal. per min. per sq. cm. measured normal to the sun's rays. Energy from the earth is equivalent to the energy from an infinite flat plate having the same characteristics of emissivity and reflectivity as the earth and its atmosphere (with the assumed geometry, diffusion may be included with reflection), at least to a first approximation.

The earth radiates energy at a rate equivalent to a body at 246 deg. C. abs.[10] This low effective temperature results from the very efficient blocking exercised by the atmosphere. On the other hand, 36% of the incident sun energy is directly reflected or diffused by the earth.[10] Thus the earth creates an energy flux of

$$8.22 \times 10^{-11} \times (246)^4 + .36 \times 1.94 = 1.00$$

cal. per min. per sq. cm. parallel to the earth's surface. The effective receiving area is ½ the outer area of the sphere. For the solar radiation, the normal projection of a sphere, or ¼ the surface area, is the effective receiving area. Hence, the radiation required per sq. cm. of surface (for spheres) is,

$$1/4 \times 1.94 + 1/2 \times 1.00 = 0.985$$

cal. per min. per sq. cm. Using the formula for radiation, the equilibrium temperature is obtained as follows:

$$T^4 = \frac{.985}{8.22} \times 10^{11} = 1.2 \times 10^{10}$$

T = 331 deg. C. abs. or 138 deg. F.

For a perfectly reflecting body (also true at night) in the region of incident sun energy, which, however, absorbs earth radiation and radiates as a black body at these low temperatures, the equilibrium temperature is given by considering only the earth's radiated energy. Then,

$$8.22 \times 10^{-11}\, T^4 = 1/2 \times 8.22 \times 10^{-11} \times (246)^4$$

$T = 246/\sqrt[4]{2}$ = 207 deg. C. abs. or − 85 deg. F.

Thus, a wide range of temperatures may be expected, depending on the optical characteristics of the body (especially as regards shininess) and the time of day.

Temperature of body when immersed in a field of 1,700 deg. F.: Reference to Fig. 14 shows that the ambient temperature at an altitude of 180 mi. above the surface of the earth is approximately 1,700 deg. F. Using McAdams'[14] Eq. 24 for the heat transfer

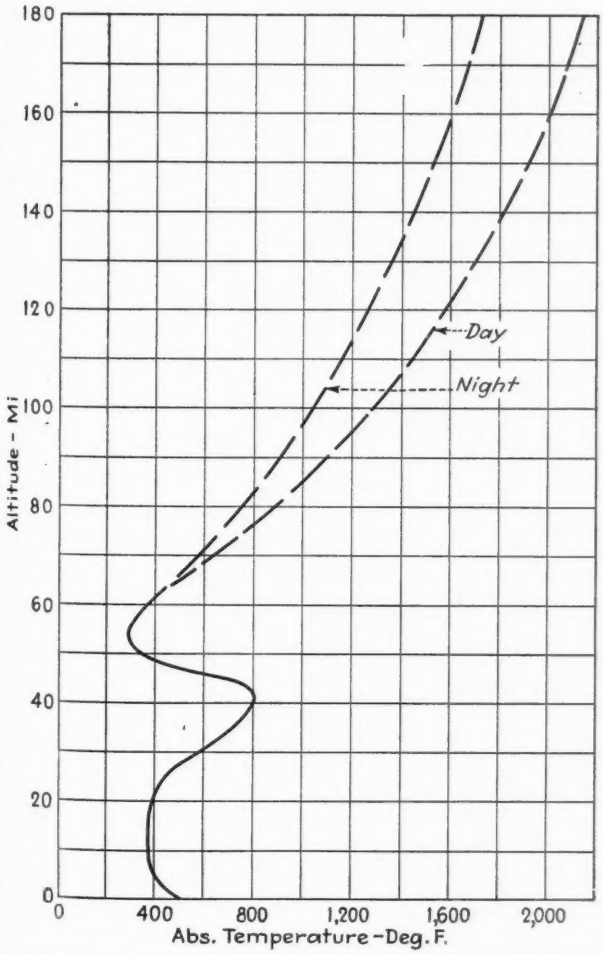


Fig. 14. Chart of temperature in deg. F. absolute vs. altitude.

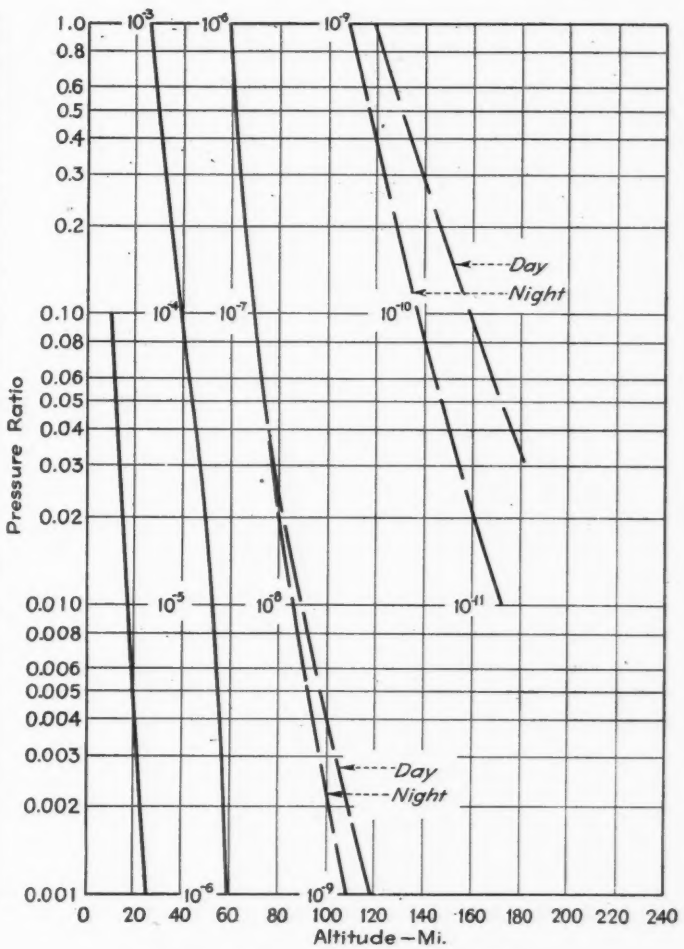


Fig. 15. Plot of pressure ratio vs. altitude.

from large horizontal pipes, the equilibrium temperature of the body is found to be 48 deg. F. abs. or –410 deg. F. This is because the density of the fluid, when evaluated at the film temperature, is approximately $10^{-21} \times 0.0765$ lb. per cu. ft.

The authors are unable to explain why the ambient temperature field at 180 mi. above the earth is of the order of 1,700 deg. F. Temperature variation vs. altitude at great heights has been calculated using the necessary physical data obtained from observations of the aurora borealis and electron showers.[10]

Meteoric dust: According to Oliver,[15] a rough estimate for the amount of meteoric material striking the earth's atmosphere per day is 100 tons. Hence, if it is assumed that particles of less than 1/1000 lb. are harmless and if it is also most conservatively assumed that all particles weigh exactly 1/1,000 lb., then there would be $100 \times 2{,}000 \times 1{,}000 = 2 \times 10^8$ particles of dangerous size striking the atmosphere per day. Now, the area of the earth is $4\pi \times 4{,}000^2 = 2 \times 10^8$ sq. mi. There is, therefore, 1 particle per sq. mi. per day. Since even at these projectile speeds the body is probably relatively stationary compared to the meteoric particles (say 5 mi. per sec. as against 50), the probability of a direct hit in a day of flying time for a body 30 by 6 ft. is $30 \times 6/5{,}280^2$, or approximately 1 in 160,000. Thus, one could expect, on the average, to spend 500 yr. at these altitudes before encountering a particle—even under the very conservative assumptions of this calculation.

Molecular mean free path: As a matter of interest, the mean free path of the air molecule vs. altitude is plotted in Fig. 17. The free path in ordinary air is about 6×10^{-6}cm. or a 400,000th part of an in.[16] When all the molecules of air move with speeds which conform to Maxwell's law, the average free path is found to be $1/\sqrt{2}\pi\, \nu\, \delta^2$, where δ is the dia. of the molecule considered as a sphere, and ν is the number of molecules per unit volume.

The length of mean free path is independent of the temperature or speed of molecular motion, and depends only on the density of the gas. In general, the length of the mean free path is inversely proportional to the number of molecules per c.c. of gas. In interstellar space,[16] the density may be as low as 10^{-24} gm. per c.c. (0.6246×10^{-22} lb. per cu. ft. or $\sigma = 0.817 \times 10^{-21}$) and the free path is of the order of 10^{15} cm. or 62,000 million mi. In internebular space, where the density of gas may be as low as 10^{-29} gm. per c.c. (0.6246×10^{-27} lb. per cu. ft. or σ equals 0.817×10^{-26}), the free path will be of the order of 0.62×10^{16} mi., or about 1,000 light yr.

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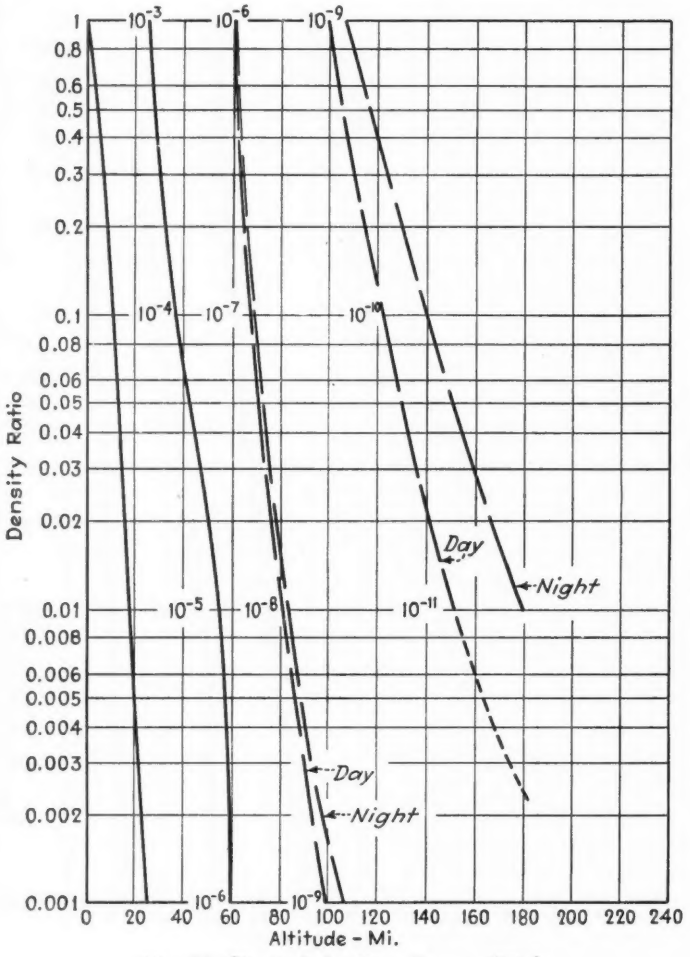

Fig. 16. Chart of density ratio vs. altitude.

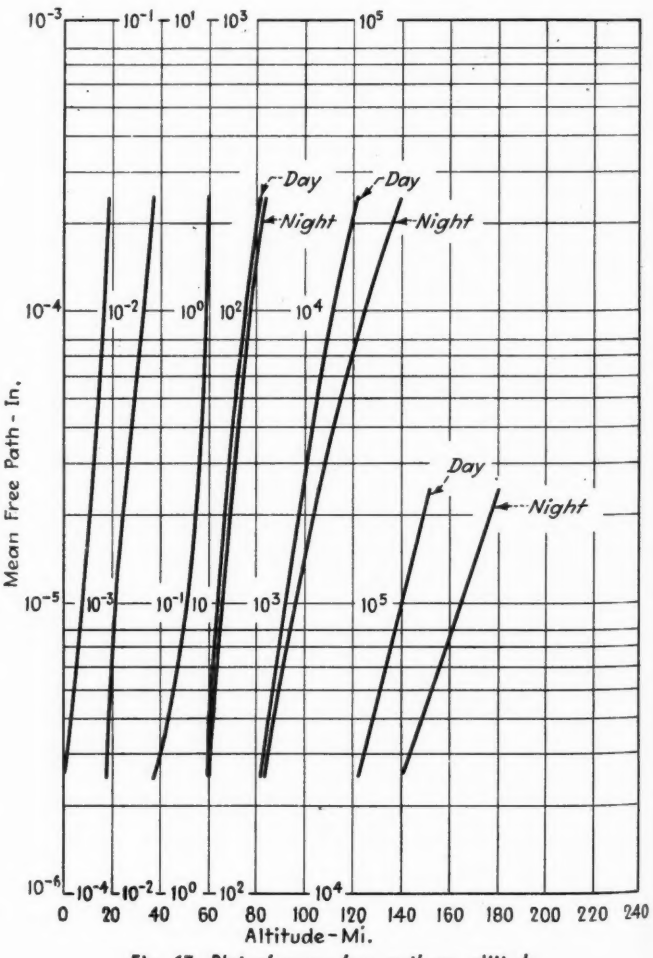

Fig. 17. Plot of mean free path vs. altitude.

Landing Analyses For Flying Boats and Seaplanes

PART III

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Skipping — once condoned — was quickly condemned when war necessitated increased flying boat activities. Landing hazards at crowded bases, in unsheltered areas, and with greatly "upped" loads called for elimination of this phenomenon. And to safeguard heavy peace traffic, it's still "thumbs down" . . . Final phase in these detailed studies.

WE NOW CONSIDER landing stability and skipping. Until a few years ago, hydrodynamic stability considerations were applied almost entirely to the takeoff regimen of a flying boat, and whereas hydrodynamic instability was conceded to be the most critical phase of flying boat design, little or no consideration was directed toward the relatively less severe forms of landing instability. Then, too, much of the severe landing instability developed at a later date on craft that had been modified to eliminate takeoff porpoising, so that the cure for the one condition aggravated the other.

Hydrodynamic instability is an inherent tendency for the seaplane to oscillate in heave, pitch, or yaw, or in combinations, during takeoff or landing. Instability resulting from the first two types of oscillation is the phenomenon commonly known as porpoising; whereas oscillation in heave alone —where the hull actually leaves the water with little, if any, change in trim —is commony defined as skipping.

Prior to the last war, there were relatively few flying boats in operation, and for the most part these craft were flown at design gross weight, from large protected areas and by experienced pilots. And except for an occasional training flight, little night operation was scheduled, and then not under the severe conditions of a total blackout. With the approach of war, flying boat activities were greatly reinforced, resulting in crowded bases, use of small and unsheltered operational areas, and necessity for training large numbers of pilots under rigid wartime conditions of blackout and greatly increased overloads. Planes that could not be landed in any reasonable attitude, in a total blackout, between rows of moored craft in a crowded harbor, lost the major portion of their strategical and tactical usefulness. Accordingly, it became imperative to eliminate the objectionable, but heretofore, condoned, skipping. And since these wartime conditions reflect, to a large extent, normalcy in the accelerated postwar period, it is essential that all new designs be free of this hazard.

Skipping can now be predicted accurately. Today, designers of flying boats have at their command a powerful tool, in the form of the dynamically similar scale model, which can be employed to prevent this hazardous hydrodynamic phenomenon in full-scale seaplanes. The following discussion outlines the general physical aspects of skipping and some of the predominant variables involved, also their effect on this phenomenon.

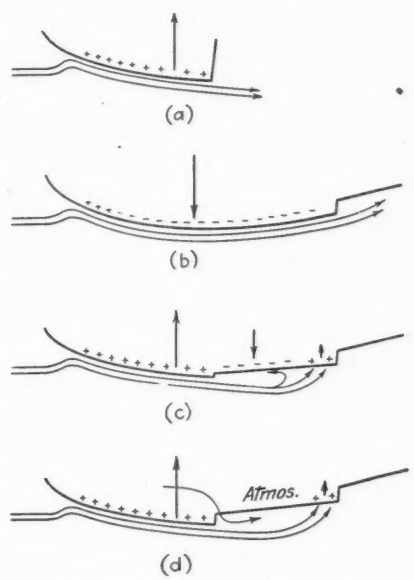


Fig. 14. Planing flow lines and pressures on planing bottoms.

Landing Instability Factors

The basic fact upon which we may establish our approach to skipping, is that all forms of instability associated with high trims are fundamentally a function of the hull afterbody. Numerous tank tests have conclusively shown that a planing forebody alone, with the afterbody completely removed, has no high angle instability. Since some form of restoring moment is necessary at low speeds to counteract the powerful bow-up hydrodynamic moments of the forebody prior to establishing planing, it is not feasible to eliminate high angle instability through complete removal of the direct cause. However, this limits the study of skipping to an analysis of the characteristics and influence of the afterbody form and position.

In pure planing, the afterbody of a hull serves no useful purpose; in fact, if the planing is stable, it may be removed and the character of the planing will not be altered—indicating that the afterbody does not enter into the function. Hence, any deviations from pure planing, such as skipping, can be assumed to be primarily associated with afterbody interferences—that is, the influence of the afterbody on the curvature of the flow leaving the forebody at the main step, with the resulting forces and moments.

Fig. 14 schematically shows the flow lines, forces, and pressures existing on a series of forms running in water. The theorem of momentum indicates that if the water flows about an obstacle and leaves it with a velocity and vertical component directed downward, the

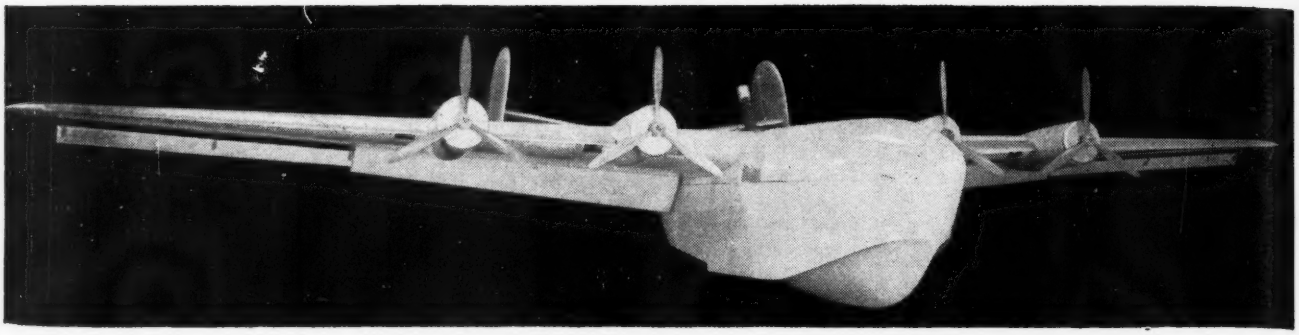


Fig. 15. Typical powered dynamically similar flying model.

body will be subjected to a reaction from the water with a component upward—a sustaining force (*a*, Fig. 14). But, if the water leaves the obstacle with a velocity and vertical component directed upward, the body will be subjected to a reaction directed downward—that is, it will tend towards greater immersion (*b*, Fig. 14). Hence, it is obvious, that to satisfy the momentum theorum, a break or discontinuity should be provided at the aft end of a planing surface if the downwash is to develop with the resulting positive pressures on the planing bottom.

Since the case illustrated in *a*, Fig. 14, is not feasible at low speeds, an afterbody has been added in *c*, Fig. 14. Because of the aerodynamic penalty involved through the use of rapid changes in section, the discontinuity or step is the minimum that will assure complete separation of the flow. We note that the downwash from the forebody, resulting from the release of pressure, deflects upward in the form of a following "roach" which strikes the end of the afterbody at a positive angle of attack. As in the case of the forebody, a local region of positive pressure develops. Because of the jet pump action of this flow of water, a region of negative pressure is induced throughout the distance from the main step to the point of impact of the roach, producing a strong downward force resulting in a bow-up moment.

During takeoff, as the speed is increased, at relatively low trims, the forebody roach will pass beyond the second step, thus eliminating the jet pump action and relieving the afterbody pressures to approximately atmospheric. However, when landing at relatively high trims, the second step will be in contact with the water surface, and the ventilation of the afterbody must come from another source. If ventilation is not obtained rapdily, the bow will trim up under the influence of the downward reaction and the craft will leave the water.

The minimum step provided in *c*, Fig. 14, to satisfy the momentum theorem, will permit the entrance of some air at atmospheric pressure to the region aft of the step, which will tend to relieve the down load on the afterbody because of the water forces. For complete ventilation, a sufficient volume must be supplied to the region aft of the step to satisfy the jet pump action. This indicates that for a condition where afterbody suction is apparent, the negative pressures can be relieved by deepening the step to the point where an adequate amount of air from the chines can be ducted along the step to the afterbody (*d*, Fig. 14).

Starting with a new design, and being aware of the facts previously discussed, it is a simple procedure to build a powered dynamic model and determine, in the towing basin, the required depth of step to satisfy the requirements of afterbody ventilation. However, in many cases it has been found necessary to correct skipping on designs already built and often on those in mass production. Deepening the step in such case is practically prohibitive from a production and tooling standpoint. Because of the geometry of the hull bottom, the step can be deepened only by rebuilding the entire forebody to a lower baseline, raising the entire afterbody, or by moving the step aft. The latter method, in practically every instance, is impossible, considering porpoising during takeoff.

Most of the skipping in current designs is because, in the absence of adequate powered dynamic model tests during the initial design, the steps were located too far aft. And as a result of flight tests or later checks in the towing basin, the steps were moved forward to obtain takeoff stability. Forward movement of the step (as much as 2 ft. in several designs) greatly reduced the step depth and resulted in skipping in the majority of cases—where none existed before. For these cases, it is essential that some method other than deepening the step be used for supplying adequate ventilation.

Aside from the example discussed above, it has been found, from testing models of new designs, that in many instances of high beam loading and length-beam ratio, the required step depth becomes excessive from considerations of hump resistance and aerodynamic drag. Hence, it is desirable to use the minimum depth of step consistent with these requirements, and supplement the air supplied from the chines by direct ventilation through the bottom of the hull. This allows the supplementary air to be efficiently ducted to the particular region of highest effectiveness. The design information is readily obtainable from tests on a dynamically similar model in the towing basin.

Test Procedure

A typical powered dynamically-similar tank model having a 17-ft. wing span and capable of self-propelled free flight is illustrated in Fig. 15. With this model it is possible to determine experimentally, in the towing basin, the free-to-trim tracks for the complete range of elevator angles and the correct step position for stability during takeoff, throughout the entire range of loadings and flap positions. Being dynamically similar in all respects as to center of gravity, load, power, and inertia, the model will reproduce all oscillations of the corresponding full scale airplane. The power and controls are operated remotely and, prior to testing, the model is supported on a dynamometer and towed in the air. During these runs, lift and moments vs. angle of trim are determined for all flap and elevator positions. These values are then adjusted by stabilizer movement, control stop settings, leading edge slot position, etc., to match the full scale aerodynamic characteristics. Upon establishing the basic hydrodynamic characteristics of the design for takeoff, it is then possible to fly the model and study the requirements for landing stability. (These methods have been developed over a period of years through extensive testing and development by Convair in close cooperation with NACA Hydrodynamics Section at Langley Field, Bureau of Aeronautics, Experimental Towing Tank Section at Stevens Institute of Technology, and various manufacturers of seaplanes. The methods were originally based upon, and extensively developed from,

early experimental work done by the British[8] in the early '30's.)

Fig. 16 shows the bottom view of a model hull in the vicinity of the step, illustrating a typical supplementary step ventilation duct assembly. The watertight air chamber is located directly above the removable block carrying the step, and is ducted to the interior of the hull above the waterline. This arrangement allows steps of any planform, location, or depth to be ventilated to the chamber. Location and area of the vents may be altered at will by merely cutting the vent openings in the step block.

In setting up the test program, it is important that the takeoff and landing stages be closely correlated. As pointed out previously, one may directly affect the other. Since the decision as to whether adequate ventilation shall be provided by step depth or supplementary air is subject to many considerations, the tests should be so set up that the minimum requirement for both methods is obtained. This requires that the region in the vicinity of the step on the model be made easily replaceable, as shown in Fig. 16, so that various positions and depths of step can be tested. A ventilation chamber should be provided, which covers at least half of the beam transversely and will open to the region aft of the step in any of the step positions. The ducts leading to the air chamber must be larger than any anticipated vent area to prevent throttling.

For the landing configuration, a series of airborne runs are made, during which the model is trimmed with the elevators to the landing trim and landed by cutting the power to the towing carriage. The landing trims should cover the entire angular range, from approximately 3 deg. trim to the stall, in not more than 2 deg. increments. Character, amplitude, and number of skips are recorded. If skipping is evident prior to the stall, the step depth is increased and the series of landing repeated.

Upon attaining stability throughout the range of landing trims, the takeoff range of stability is checked for the takeoff configuration. The airplane must be stable for the entire range of design center of gravity positions and gross weights.

Following of this procedure will assure that the airplane will be stable for both takeoff and landing. If the design is one of a high performance craft and the beam loading and wing loading is high, it will be found that a very deep step is required to maintain stability. Tests should be made to determine to what extent the depth can be reduced by supplying supplementary ventilation to the afterbody. This will consist of a series of trial and error landings wherein the step depth and vent area are varied to the point where, for the maximum practical area of vents, the minimum depth of step is obtained. Since the chines will always supply some ventilation, the supplementary air should be supplied as near as possible to the keel.

Upon obtaining the minimum step depth in this manner, it is necessary to recheck the takeoff condition for stable range and correct step location.

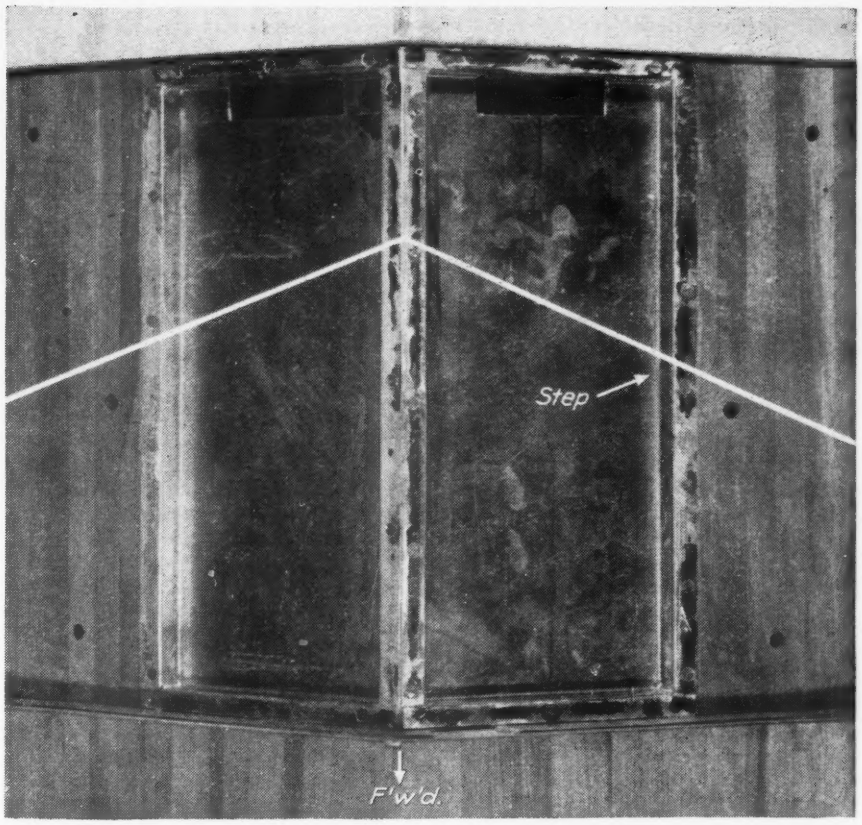


Fig. 16. Typical model installation of supplementary ventilation duct.

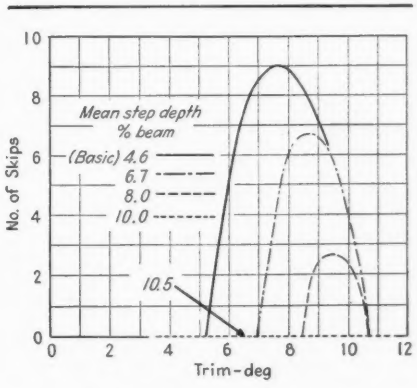


Fig. 17. Effect of step depth on skipping characteristics.

With the basic step parameters established, it is then possible for the Aerodynamics and the Design Groups to weigh the overall merits of the shallow step vs. the deep step. If the question is a critical one, it may be necessary to obtain hydrodynamic hull resistance data for both configurations. An excessively deep step may increase trim and resistance at the hump by as much as 15 or 20%, which in some cases will make takeoff impossible. Conversely, a step that is too shallow, coupled with a low angle of afterbody keel, may increase the high speed planing resistance excessively—particularly for airplanes with very high getaway speeds.

Design Criteria

Conclusions regarding correct procedure for designing a hull that will not skip, must through necessity, be very general, for each problem involves individual considerations. Because of the interdependency between skipping and porpoising, the strictly quantitative analysis is obtained only from the complete similitude represented in the dynamically similar model. From a compilation of a number of tests, both model and full scale, on various types of seaplanes, the following criteria have been well established:

1. For satisfactory skipping characteristics without the use of supplemental ventilation, the step depth should not be less than 8% of the beam.

[8] Perring, W. G. A., and Glauert, H., *Stability on the Water of a Seaplane in the Planing Condition*, British R. and M. No. 1493, Sept. 1932. Also Coombes, L. P., Perring, W. G. A., and Johnston, L., *The Use of Dynamically Similar Models for Determining the Porpoising Characteristics of Seaplanes*, British R. and M. No. 1718, Nov. 1935.

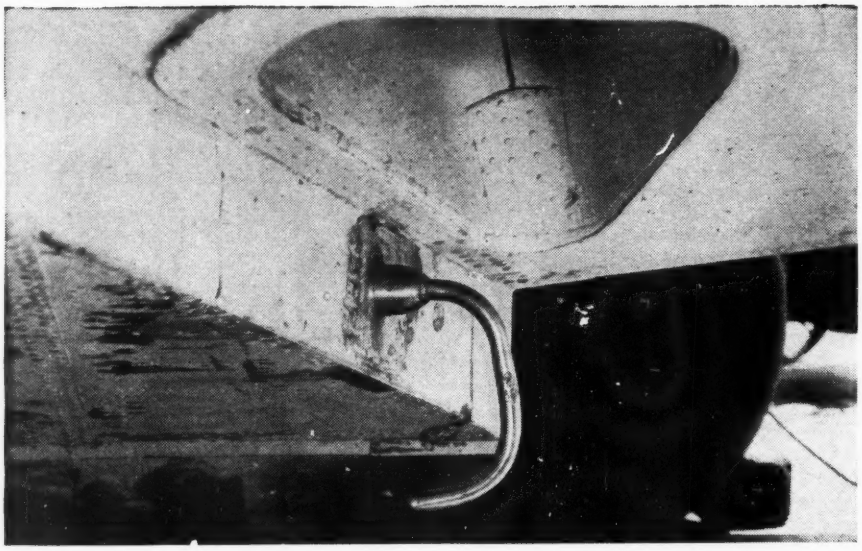


Fig. 18. Typical full scale installation of supplementary ventilation.

2. The V-type step (with apex pointed aft) is, in general, superior to the more usual transverse step from a skipping standpoint.

3. Supplementary ventilation is very effective in eliminating skipping. Vents should be located directly behind the step in the afterbody flat, and as close as practical to the centerline.

4. Supplementary ventilation ducts located in the vertical rise of the step are ineffective.

5. Static ventilation to the interior of the hull is sufficient, and the ducts should be as straight and short as possible, with no contraction. No appreciable improvement is gained from pumping or ramming the air.

For illustration, a typical example is presented—an actual case where both increased step depth and supplementary ventilation were studied on a $\frac{1}{8}$-scale dynamic model. Effect of increased step depth is clearly shown in Fig. 17, where the number of skips (a direct measure of severity) is plotted against the landing or contact trim angle. The basic airplane with a step depth of 4.6% of the beam is seen to skip quite violently between the trims of 5.2 deg. and the stall at 10.7 deg., the number of skips and the range of trims for the full scale airplane checking very closely. The full scale craft results are believed to be slightly conservative because of corrective control available to the pilot, which can be accurately simulated only with the greatest difficulty on the model as a result of the time scale factor. In accordance with the dimensional laws of similarity, the events on the $\frac{1}{8}$-scale model occurred, roughly, three times faster than full scale.

As the depth of the step is increased, Fig. 17 shows that the limiting angle of trim increases and the skipping becomes less violent. For this particular craft, complete stability was not attained until the depth of step reached a value of 10.5% of beam. In other words, a 130% increase in step depth would be required. This value appeared excessive so the program was continued to determine the requirements for supplementary ventilation.

With the basic step block installed, a large supplementary air duct was incorporated, which extended for the entire beam directly behind the step. With this installation, it was possible to close off portions of the opening and study not only area but lateral location of the duct. As stated previously, the area next to the keel was the most efficient. Starting with the total area, which gave a vent coefficient of 5.13, the area was reduced until further reduction resulted in skipping. The required minimum vent coefficient was determined as 2.38.

$$C_v = A_v \times 100/b^2 \qquad (47)$$

where C_v is the vent coefficient, A_v the vent area in sq. in., b the beam in in.

On the basis of these results, the obvious solution for the full scale installation was to supply supplementary air behind the basic step, and this final installation in the full scale airplane is shown in Figs. 18 and 19.

The designer should have little difficulty in preventing the hull from skipping if he makes adequate provision to get the necessary air to the center of the afterbody just behind the step, either by deep steps or ventilation. The deep step is nothing more than a somewhat inefficient air duct from the chine to the keel. If there is access to dynamic testing equipment, the designer will find that well-located direct venting, as determined from the dynamic model, will be more practical in most cases and allow shallower steps giving lower aerodynamic drag.

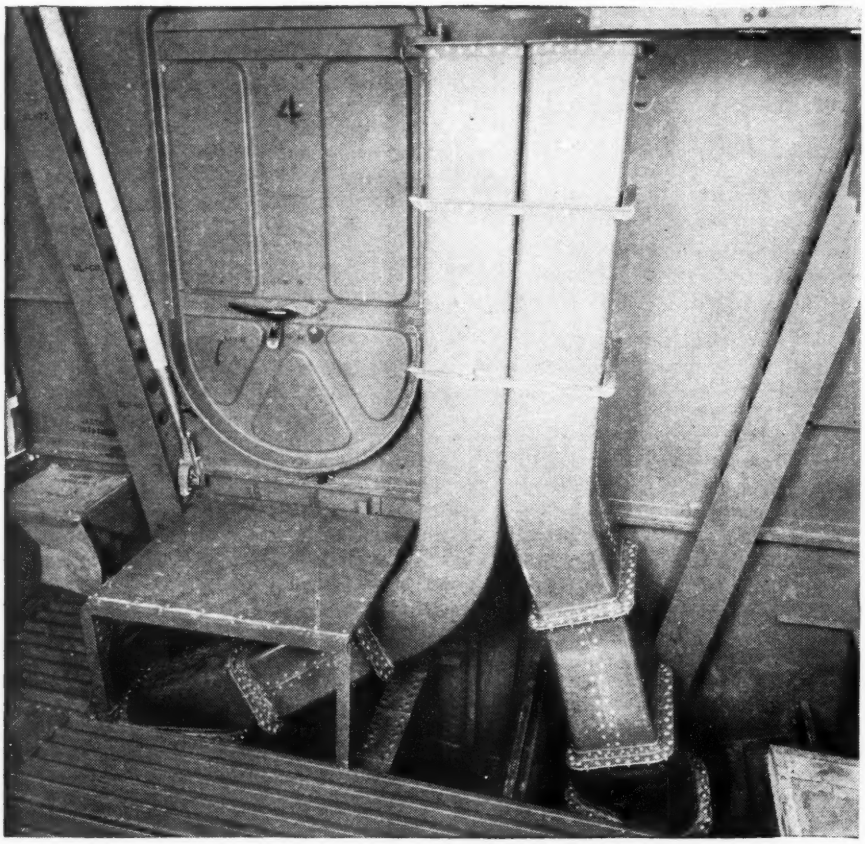


Fig. 19. Full scale ventilation duct installation.

STANDARDS ENGINEER STILL FACES HIGH HURDLES*

By B. C. BOULTON, *Engineering Divisional Staff, Douglas Aircraft Co.*

For greater general standardization effort, a definite need is indicated for more active support from engineering management—particularly in the aircraft industry. In addition to presenting some examples of cash dividends and improvement in product quality as a result of standardization, the author notes trends in this important field slated to ease the problem of designing for production.

TOO OFTEN in a busy engineering department, standards engineers are just tolerated or considered as overhead, necessary perhaps but not productive, so far as getting on with the main job is concerned. Engineering executives will generally agree that standardization has some value, yet argue that the benefits are too intangible and too far in the future to warrant more than a low priority for standards work in comparison with today's urgent tasks.

If standardization is as important as many who have studied the problem feel, who is responsible for the too mild attitude toward it among our operating managements? In considerable part it is felt that the responsibility lies squarely on the doorstep of the standards organizations and to a lesser extent on the standards engineer himself.

Publicity should stress not only the positive side—the gains and achievements—but also the negative side—the frequent high costs, inefficiencies, and inadequate technical quality due to lack of standardization. The burden of proof is on those backing it.

We will consider a few examples, some from Douglas experience, others contributed by engineers from other companies who have met with similar problems.

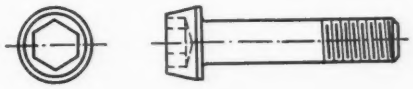
Economy Through Redesign

Take the story of the high strength internal wrenching bolt used on the Douglas C-54. These bolts were originally designed by Douglas to conserve weight and space. The table below summarizes the price picture before and after standardization. The extraordinary decrease in cost is due largely to more efficient manufacturing methods and greatly increased production because of wide usage resulting from standardization. During that process, design changes produced a stronger and lighter bolt—the weight saving amounting to 8 lb. per airplane.

Internal Wrenching Bolts Used On C-54

Dia.	Bolts per Plane	Cost per Plane Douglas design	Cost per Plane NAS Standard	Saving per Plane
1/4 & 5/16.....	39	$49.70	$8.34	$41.36
3/8 & 7/16.....	56	91.49	16.77	74.72
1/2.....	96	166.00	44.00	122.00
5/8, 3/4, & 1.....	26	51.44	20.78	30.66
Totals.....	217	$358.63	$88.89	$268.74

Cost savings approximate well over $600,000 for the total contracts involved. It is startling that standardization of a single class of parts on but one type of plane should have such an economic effect.



Redesign of Douglas C-54 internal wrenching bolt to this NAS standard resulted in a stronger and lighter bolt and saved company over $600,000 in entire contracts involved. Standardization here resulted in larger production of item, thereby lowering cost.

Next is an example of unusual interest, but for these other reasons—(1) it is an item used for years by the million without critical thought; (2) standardization has as its objective improved functional quality, cost reduction being a by-product; and (3) the man who initiated and is conducting the work is not a standards engineer but R. R. Richolt, Lockheed hydraulic and mechanical staff engineer.

The article which finally offended Mr. Richolt's sense of design fitness was the aircraft ball bearing pulley. The development of over 300 special pulleys in current use similar to the AN210 series came about as a result of the latter's inadequacies. The most basic change is in pulley capacity ratings based on the limit load in the cable system. Resultant pulley load, with a safety factor of 2 and allowable bearing stress of the sheave material, determines sheave design. With the AN series, only the bearing was protected by rated capacity and the sheave could be so overloaded as to cause early failure. To aid the designer in intelligent selection of a pulley for a specific application, with due regard for pulley and cable life, NAS standard drawings will contain two SN curves, one for the sheave and one for the cable.

Bearings will be specially designed to meet pulley requirements. Hubs will project sufficiently to provide adequate clearance and will be wide enough to permit a much lighter double-row ball or needle bearing that will give more stability than the present single-row. An important feature of secondary control pulleys for engine controls is provision, in two sizes, of a .625-in. bore to permit gang mounting on a tube. The proposal also includes pulleys capable of being aligned within 2 deg. limits and locked, primarily for prototype and early production airplanes. The more efficient pulley design possible when definite performance specifications are furnished saves about 40 percent weight on flight control pulleys.

Because it shows so clearly why a properly developed modern standard excels from both a quality performance and production viewpoint, a summary is given of NAS pulley development. The initial proposal was prepared by Mr. Richolt and a representative of a bearing manufacturer; this was presented to the NASC Controls

* From, "Standardization Tomorrow?", a paper presented by author before ASME. In preparation of this material the author wishes to acknowledge suggestions and helpful criticism received from Warren V. Boughton (Douglas) and Glen M. Aron (Northrop), also the assistance of L. J. Catlin (Douglas), C. T. Torresen (NAA), and W. H. Korff and R. R. Richolt (Lockheed) in supplying data for examples given in this article.

Subcommittee, whose suggestions were incorporated; a design policy questionnaire was sent to all aircraft companies for comment; then a conference was called of twelve leading pulley and bearing manufacturers. Their experienced representatives, working with two aircraft engineers, studied it in detail and made recommendations; a special panel representing the three groups concerned was chosen to draft the final design envelope and performance requirements; and these have now been submitted to all aircraft companies for final comment and approval.

Under the proposal, 20 pulleys cover all requirements and will not have to be supplemented except in minor degree. Their cost will be about the same as for AN210 pulleys. A large cost saving however will occur as a result of elimination of "specials."

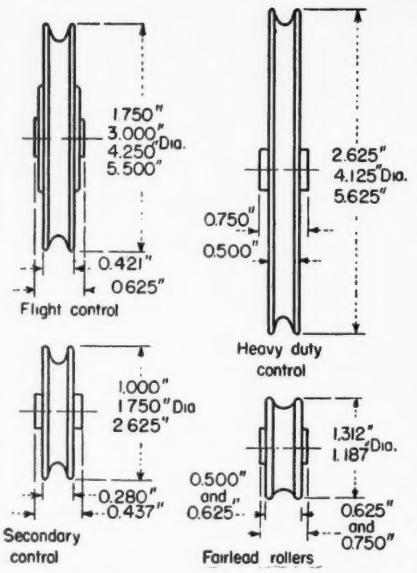
In complete contrast to the preceding example is the case of standardization of the AC811 series of hydraulic fittings. The AC811 series was originally proprietary and made by one manufacturer. However, procurement demands were so great that several sources had to be developed. The difficulty was that the available drawings, as released by the Army, were not completely dimensioned; critical dimensions were specified by calling out a tool number. Much confusion arose in interpreting these drawings, and supposedly identical parts produced by different vendors differed. Finally Lockheed sponsored an NASC project to prepare a set of standard drawings. Slight changes in design and tolerances made it possible to machine the fittings with standard tools on automatic equipment. The NASC proposal was presented to the Services and resulted in WPD Directive 6-W-2. Large cost reductions resulted, as shown by the following typical parts:

AC811 Straight Connector Fittings

Part No.	Price Based On Original Dwgs.	NASC Dwgs.	Percent Reduction
HT12D	$.57	$.26	54.5
HT4D	.114	.087	23.5
CT5	.12	.128	42
HT8-6D	.36	.20	44.5
HT6D	.231	.10	56.5

In 1944, Lockheed as a result of this work saved $406,000 over previous prices and greatly facilitated procurement. In this instance, standardization did not change functional quality but powerfully affected economic efficiency.

Importance of intelligence in choosing a standard to meet design requirements is well brought out in connection with drawing revisions changing hose clamp usage on the Douglas C-54. Instead of using more expensive and heavier AN748 clamps for all purposes, their use was restricted to fuel, oil, coolant, and hydraulic lines, which constituted 15 percent of the 1,000 clamps employed, and at the suggestion of standards engineers, another type was employed for all instrument, vacuum, de-icer, air vent, and drain lines comprising the remaining 85 percent. This decision saved some 50 lb. and $42 on each airplane (or about $100,000 total on the contract) as well as a great saving in installation time.



Better functional qualities are purpose of these proposed NASC pulley standards. Previous type's inadequacies resulted in necessity for variations in design, resulting in large number of "specials". This proposal is designed to bring pulley standards up-to-date and simplify stockroom procurement.

A type of saving which standards engineers are constantly making is illustrated by the adoption of a type of hose clamp with a wide range of adjustment. Wide variation in wall thickness of hose and consequent production difficulty in selection of the proper size of clamp, made this change important. Prior to converting to the new type, one North American aircraft model required stocking 30 sizes, which the new clamps cut to 7.

It is appropriate to note that NAA standards engineers, as a result of sponsoring the NASC hose clamp project, were largely responsible for developing and introducing the new clamp through assistance rendered the vendor in the form of engineering advice and testing. The same procedure is characteristic of the development of many valuable vendor products.

Necessity of Cooperation

Although only a few examples have been given of the countless available, they have been chosen to demonstrate the various ways intelligent standarization brings about major improvements in product quality, lower product cost, and lower overall manufacturing costs, not to forget overhead costs, reduced procurement time, and greater availability due to increased sources. These benefits are not intangible and not long range; they are here and now. They do not stop but are permanent gains paying dividends month after month.

The fields for application of standardizing principle are rapidly broadening — not narrowing. The highly trained design engineer is entering the picture to an increasing extent. While the need will remain for a specialized standards group in each company, there must be recognition of the necessity for some decentralizing of the standards function in engineering, for some participation by high type design personnel. The benefits from a standard are more than proportional to the quality and soundness of that standard. We need a budget of engineering hours, reasonable in amount but honored, and not grudgingly.

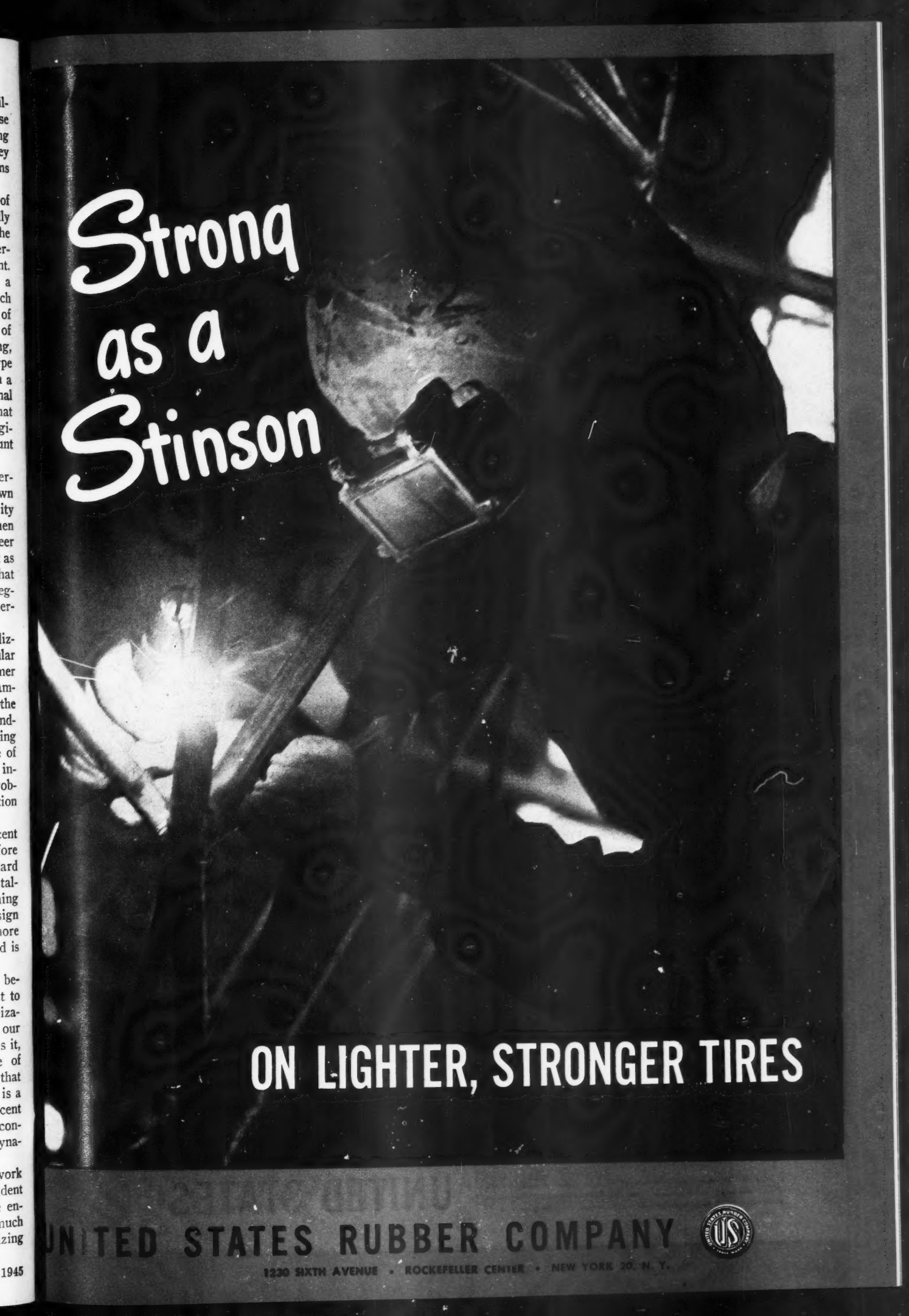
Most important of all, top engineering executives should make clear, down the line of organizational authority through the operating level, that, when the need arises, a design engineer should be assigned to standards work as a part of his legitimate activity so that he is not made to feel that he is neglecting his job and his company's interests.

What is the nature of the standardizing process? The term, in popular conception, is frequently a misnomer and the cause of a prejudice that hampers standards work. Cooperation is the basic element in standardization. Standards work involves pooling the varying knowledge and practical experience of able specialists. It serves to focus intensive thought on a particular problem, and it brings about a consideration of all its aspects.

In a new or difficult field, 90 percent of the effort may be expended before the actual work of drafting a standard begins. Discussions, however, crystalize thinking and assist in establishing basic principles on which sound design can proceed. Sometimes a year or more may pass before a concrete standard is evolved.

Evident is a trend worth noting because it is a partial answer at least to one of the chief barriers standardization has always faced—the fear, as our English friend, G. H. Nash, phrases it, which many able designers have of standardization. This is a feeling that once a standard has been set up it is a fixed, dead thing. Any study of recent standardization indicates that the contrary is true: It is a progressive dynamic process.

One of the broad trends in this work that has become increasingly evident within the last year or two is the enlargement of its scope. While much remains to be done in standardizing



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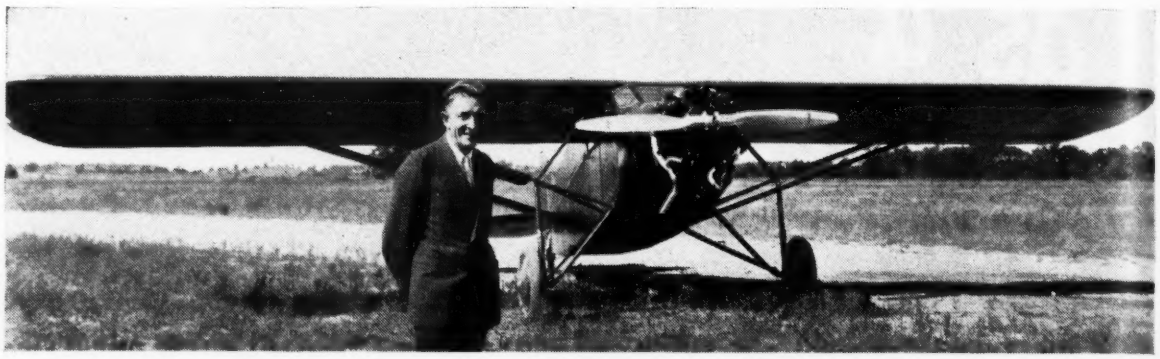

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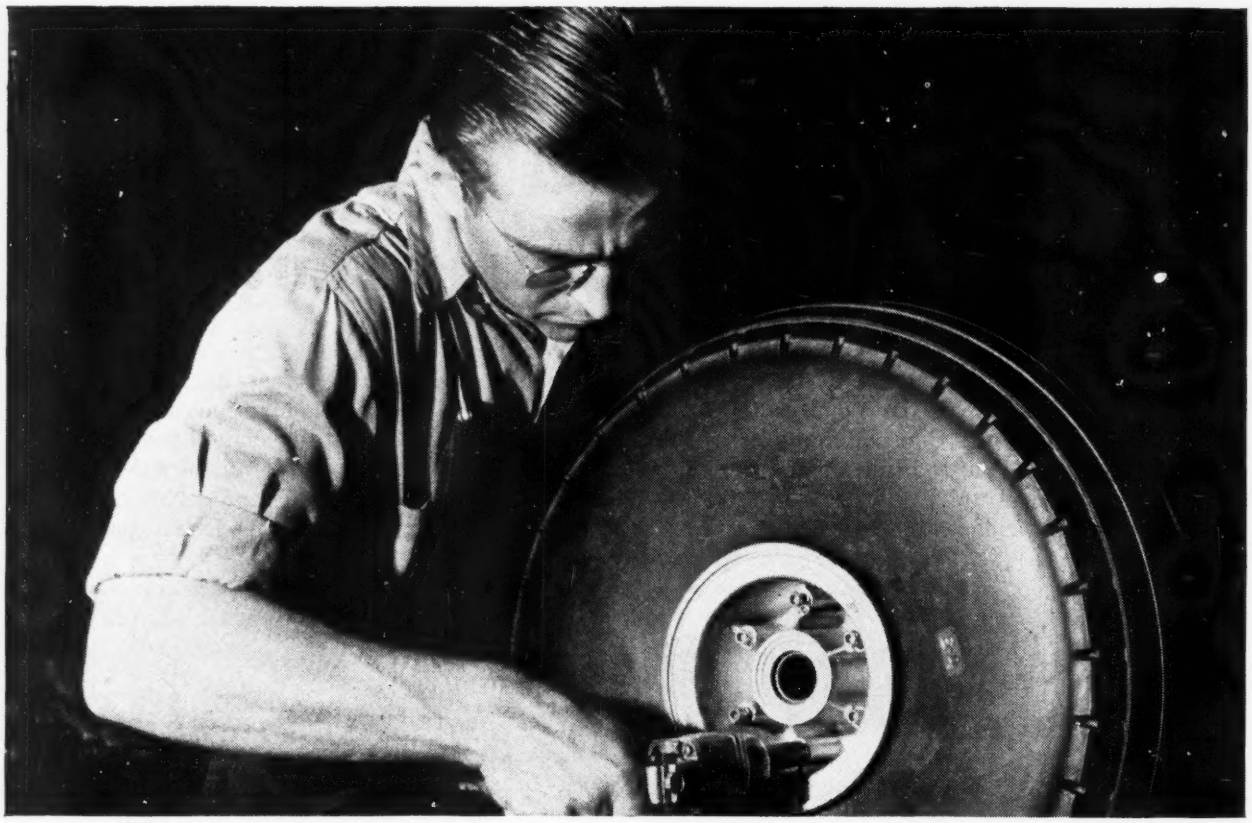

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simple or "element" parts, standardization of more complex parts and assemblies opens another extremely important and relatively new field. Certain airplane components because of their nature have always been in effect standards in that the same items are used on many types of airplanes. Such components are engines, propellers, wheels, tires, brakes, instruments, and many equipment items. Designers are accustomed to having these furnished, and with few exceptions accommodate the airplane design to their dimensional and functional requirements.

However, other parts have, through precedent, always been considered as under the airplane designer's control and are normally special for each airplane. Owing to the aggressive action of the NASC Electrical and Hydraulic Subcommittees, these lines of thought have started to crumble in a number of places. It was found, in the case of circuit breakers, connector panels, relief valves, hand-pumps, and 4-way selector valves, that technical requirements made it necessary to take cooperative action, through standardization, in order to secure proper function and quality.

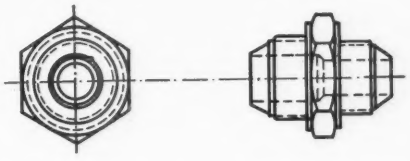
With other parts or assemblies more intimately affecting the airplane, there is still the strong feeling that they must be tailored to the individual airplane, necessitating new design and new tooling in each instance. It is felt that this is a debatable assumption, that there are not a few instances where a really well engineered design would be suitable for many airplanes.

If a designer were given such a part as a standard he would make the necessary adjustments and compromises inherent in the design process. The airplane would not suffer, while the part in question, as a result of the thought of many engineers during its standardization, should be lighter, superior functionally, and better from the production standpoint than with individual design. With larger requirements, tooling can be more extensive and production cost less—sometimes only a half or a quarter. A large slice of design time can be devoted to improving the arrangement and basic structure of the airplane.

One of the striking developments of the recent past has been the broadening application of the standardization principle, sometimes without conscious intent.

An example of far reaching importance is the work started by a subcommittee of the West Coast AWPC under the chairmanship of Harold Adams of Douglas. This group, composed of leading technical specialists and designers from several companies, prepared a specification setting forth limiting environmental conditions—such as extremes of temperature, pressure, humidity, vibration, and dirt—for which aircraft equipment shall be tested. Four supplementary specifications were being prepared to cover conditions peculiar to electrical, hydraulic, mechanical, and heat exchanger equipment. In addition, specifications were being written describing general methods of test to determine the degree to which equipment met limiting conditions. A number of these specifications were circulated to airplane companies throughout the country, to equipment manufacturers, and to the Services for their comments. After completion of this work, technical subcommittees of SAE will prepare, as required, detail specifications for test of specific items of equipment.

That the results of this program, participated in by representatives of all interested parties, will have a marked influence on aircraft equipment development appears clear. The problems



Standardizing drawings of AC811 straight connector fittings permitted machining them with standard tools on automatic equipment, with subsequent increase in production. Previously, critical dimensions were specified by tool numbers, sometimes resulting in variations in finished part.

of the vendor are simplified. He has to meet one set of conditions agreed on by industry, not as many sets as he has customers. A known measuring stick is set up permitting an engineering evaluation of his product. Uniform methods of test should allow acceptance of test results made in many reputable laboratories and should go far to eliminate the present costly duplication of testing. A definite incentive is given the capable vendor to improve the quality of his product.

Another cooperative effort which promises to bear fruit has been the preparation of a new specification on spotwelding. Drawn up at the request of the West Coast AWPC by members of the Western Welding Committee, it was coordinated with, and approved by, all major aircraft companies. It was then presented to WCAB as representing industry's views on a technically sound specification for insuring quality production with reasonable requirements for control and qualification testing. The degree to which this proposal is incorporated in present Army spotwelding specifications may well determine the extent to which industry will go in preparing in a similar manner sound specifications covering a number of our basic aircraft manufacturing processes. Such cooperative standardization work offers possibilities for raising quality levels in production and reducing costs throughout our industry.

An example of where the principle of standardization would perform a signal service lies in the field of materials. Conventional data and criteria concerning material properties have proved entirely inadequate and sometimes very misleading.

For instance, it has become essential to know mechanical properties of many metals both at and after being subjected to elevated temperatures; sometimes for functional design reasons and sometimes because fabricating processes may be facilitated by employing elevated temperatures. An outstanding unsatisfactory criterion is that for elongation based on a 2-in. gage length. Knowledge of this property may be of prime importance, but the conventional information is often of little value.

It is proposed that a national agency first secure industry agreement on important criteria and methods of test to determine them. With these settled it becomes possible to obtain useful and accepted data through cooperative testing on the part of material vendors, users, and government agencies.

The next step is assembling, in a carefully worked out standardized form, all the data regarding each material, including not only technical data but procurement information on sources, standard and limiting sizes, and tolerances. As this is done for material after material, there will gradually be built up a single authoritative handbook containing, in one place, data that can be referred to with confidence by all concerned.

In the coming years, there will be few subjects of as vital importance to our industry as materials. By standardization of nomenclature, criteria, methods of test, and presentation of data, our industry can take a step of great importance in eliminating duplication of testing, also discrepancies in design values, often minor but nonetheless serious.

In the past year there has been a significant trend in standardization work which has made new demands and placed new and different responsibilities on those directing and participating in standards activities. This is brought about by the fact that aviation has assumed its place among the major industries.

Our industry's requirements for new products, for precision manufacture,

and for small size and lightweight products, reliable under extremes of environmental conditions, forced technical collaboration. Necessity for functional and dimensional interchangeability of similar parts and equipment compelled standardization. The challenge was accepted by SAE and NASC standards bodies.

A critical situation arose. In their desire to do their utmost for the war effort, the industries, suddenly called on to produce products for aircraft, activated their trade associations and technical societies through whom they had previously worked. We realized the need and value of this assistance but, equally, we saw the necessity for channeling it through established agencies already handling aircraft standards work—if confusion and delay were to be avoided. The solution was a series of interlocking subcommittees on which were men serving in a liaison capacity; the objective was an integration of complex activities in many diverse industries.

In the electrical field, for example, the chairman of the NASC Electrical Installation Subcommittee was made a member of the SAE Subcommittee A-2 on aircraft electrical equipment, a body which included representatives of the American Institute of Electrical Engineers and the National Electrical Manufacturers Assn. Similarly, the two latter organizations had the same representatives on the NASC Subcommittee on which were also SAE representatives from Subcommittees A-2, A-4, and A-8, the latter two having jurisdiction over instruments and radio. Such a tie-up made possible great and rapid progress in the electrical field with no duplication of effort.

Such dealings with other long-established industries and organizations call for a considerable degree of diplomacy and statesmanship. Judgment must be exercised at those times when our views and practices conflict with those of the older organizations. Only in our own field can we expect directly to control our work and standards; in their fields, other industries must exercise such control even though we use the products. However, through foresight and a broad viewpoint we can exercise a marked influence and effective guidance with great benefit to the aircraft industry.

One of the most interesting cases of such influence was in connection with the standardization of electrical graphical symbols. For many years the electrical communication, radio, and power industries had developed their own symbols, many peculiar to a single field, and had not been able to agree to a standard. Aircraft engineers had to interpret drawings from all three groups and in addition had their own symbols. A subcommittee of the American Standards Assn., charged with the task of standardizing these symbols, finally invited two representatives of the aircraft industry, including Warren Boughton, chairman of the NASC Electrical Subcommittee, to participate. Their advent greatly expedited the work. It proved possible to secure agreement on, and to issue, a War Emergency Standard covering all fundamental symbols for the entire electrical industry of this country. Thus there was established a common engineering language, and thereafter wiring diagrams were intelligible to all.

By specifying different size hose clamps, instead of using one for all applications, Douglas saved over $100,000 on C-54 contracts, plus 42 lb. on each airplane. AN748 (left) was used for fuel, oil, coolant, and hydraulic lines, while light duty, small diameter clamp (right) was employed on instrument, vacuum, de-icer, air vent, and drain lines.

If a true picture has been presented it should be clearly evident that the aircraft industry must be represented by broad gage, technically qualified men. They must be big enough to submerge petty professional jealousies, to see that full credit, or even more, is given to other fellow's accomplishments. It is just as evident that there must be harmony between standard bodies representing the aircraft industry. Care must be exercised by each to avoid encroaching on the other's bailiwick, and each must be quick to support the other.

Charles E. Wilson, president of GE and past vice-chairman of WPB, has said, "One of the really priceless dividends we derive from the past few years is a demonstration of the fact that industry can cooperate intelligently with government. Let us extend that cooperation indefinitely."

Ranking high in importance to the war effort was the standardization work of SAE and NASC. Their efforts provided many specifications for urgently needed new materials where no recognized specification existed. Standardization of aluminum alloy and steel tubing sizes, of extrusions, and of new rolled shapes, prevented shortages which could have been so critical as to threaten disruption of airplane production lines. Elimination of hundreds of special requirements not only largely stepped up mill production but resulted in substantial decreases in production costs. Scores of standard parts have been developed and improvements worked out on existing AN standards. Overall effort has been great and reflects high credit on engineers throughout our industry who did it as well as on engineering management which authorized it. And it has not been easy for either the Working Committee of the Aeronautical Board or industry, due in large part to initial differences in approach to problems. Patience and understanding were present on both sides in these mutual efforts on the part of industry and the WCAB. The former came to appreciate better the problems of coordination between the Services and other Government agencies, and the problems of huge procurement which faced WCAB and had to be resolved. On the other hand, it is believed that the latter came to appreciate the sincerity and technical competence of industry's work and its value to them, thus acquiring an understanding of industry's problems and viewpoints.

Following Mr. Wilson's thought, many of us would like to see this hard-won relationship develop into a genuine partnership between WCAB and our industry on standardization matters. We would like to see a further strengthening of the authority and technical respsonsibility of WCAB in handling standards work for both military services. The day may come, and before long, when industry is invited to have representatives on WCAB—and we may have ANI (Army, Navy, Industry) standards.

Practical success of such a proposal requires maintenance of mutual confidence, of continued technical competence and a broad viewpoint on the part of industry, and of an understanding appreciation of, and consideration for, industry's interests and problems by WCAB. It is difficult to appraise the potentialities in such a broad development for improving the technical quality of both military and commercial aircraft, for reducing their cost, and for simplifying stocking and maintenance work in the far flung airports of the world where our future commercial and military airplanes will be serviced.

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Company is delivering line of 65-225 hp. positive-pitch airscrews fitted with manual or electric cockpit control. Minimum of moving parts, and ease of installation are key features.

DURING THE WAR, the AAF employed special controllable pitch propellers on engines in the 65 to 225 hp. category in order to increase takeoff and climb performances of liaison craft. Made by Beech Aircraft Corp. of Wichita, these C-P airscrews are now on the commercial market under the series designation R-000, the smallest unit being adaptable to Continental A-65 and C-75 engines and any similar engine with a No. 0 taper at the end of the crankshaft. Engines having a flanged-end crankshaft are not adaptable.

In tests with the R-000 type, craft have shown an increase in climb, also a decrease in takeoff run, of about 15 to 26% in comparison to those fitted with standard fixed-pitch airscrews. This model—the one used on the liaison planes—carries CAA Type Certificate No. 804.

A second and larger unit is the R-200 series for engines of 150 to 225 hp., having crankshafts with standard SAE 20-spline ends. This series has been teste . on several experimental postwar craft, and also on the Grumman Widgeon, Fairchild PT-19, and other types.

Takeoff time from water for the Widgeon was reduced by Beech propellers to 52.25% of the time required with fixed-pitch props, and ground run necessary for takeoff was cut by 30.5%. This unit, licensed under CAA Type Certificate No. 807, probably will be available for delivery this month. Electric control and constant speed governors will be available.

Positive pitch control was adopted by Beech several years ago after company engineers found that this type of propeller offers optimum performance under all operating conditions.

Blade pitch angle is continuously variable, within the operating limits of each model, and is under control of the pilot at all times. Licensed under Roby patents, the propeller has manually or electrically controlled pitch-changing mechanism. A small hand crank on the instrument panel is stated to easily change pitch on the manually controlled models, either when the engine is running or stopped.

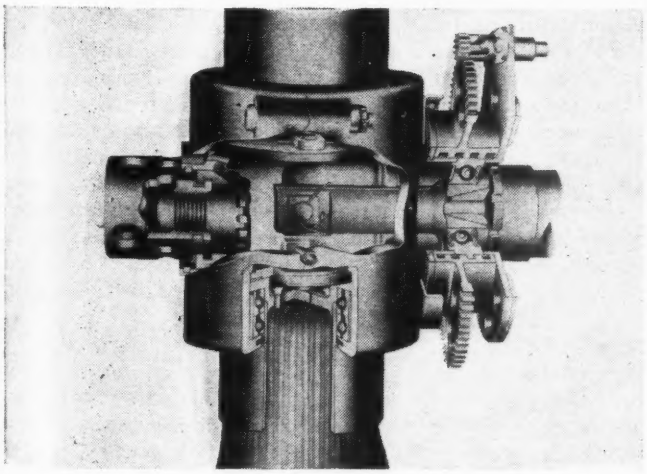
A feature of the installation is that no engine revision is required. On power plants equipped with the proper type of crankshafts, it is only necessary to bolt the pitch changing mechanism onto the front of the engine at the time the propeller is fastened to the crankshaft. The electric pitch changing control can be located at any convenient spot where a reasonably straight drive to the pitch changing gear is available.

Converting a manually-controlled Beech propeller to electric or constant speed control is possible by comparatively simple modification. This permits progressive improvements.

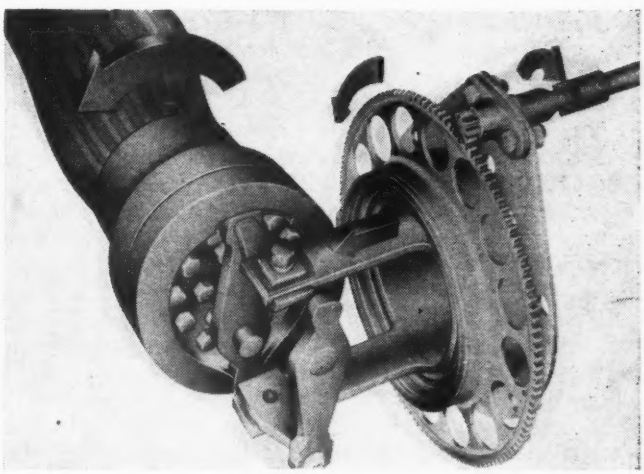
Pitch changing gear—operating only to change pitch position—requires no lubrication. The constant speed governor electrically actuates the pitch control mechanism. This permits its installation at the usual governor drive position on any engine, with a simple wiring harness connecting the governor to the electric pitch control mechanism and to the actuating controls in the cockpit.

Weight of the R-000 propeller with manual control is about 30 lb. when installed. Weight of the R-200 series varies considerably, depending on the length of the blades, which to date have been made from 73 to 96 in. disk dia. Including electric or constant speed control mechanisms, installed weight of these propellers will be from 60 to 75 lb.

Beech has other models in the design and testing stages and hopes to offer controllable pitch propellers in a complete line from 65 to 250 hp. in the near future.



Cutaway view showing details of Beech propeller crankshaft and hub attachment features. Seen are blade butt connection and bearing installation. At right are pitch mechanism bolting plate, pitch changing gears, and one of two pitch changing arms extending into hub.



Right: Pitch changing mechanism operation sequence. At upper right, actuating rod, through universal joint, rotates pinion to turn large gear, motion of which is transmitted to laterally acting arms extending to hub thereby causing pitch-change rotation of propeller.

MARKETING

OPEN HOME SALES SCHOOL FOR DEALERS-DISTRIBUTORS

By K. H. HOLMGREN,
Associate Director, Aviation Institute of Professional Sales Training

Already adopted by "big three" lightplane manufacturers and many individual operators, new correspondence course aims to put aviation merchandising on same level as that so successfully attained in other industries.

THERE IS REALLY a new day ahead for aviation if the enthusiasm for sales instruction being demonstrated by airport operators and their key supervisory personnel is any criterion. In the last 90 days alone, hundreds of the nation's aircraft distributors and dealers have enrolled in courses of sales training prepared especially for them.

The "big three" lightplane manufacturers—Aeronca, Piper, and Taylorcraft—have adopted sales training programs developed by the Aviation Institute of Professional Sales Training, and they are pleased with the response of their distributors and dealers to the courses. The manufacturers and operators realize fully that aviation cannot return to the haphazard methods of selling which existed at many airports before the war if the goals the industry has set for itself are to be achieved. Also, there will be plenty of competition for airplane sales after the immediate demand for new aircraft is satisfied.

The trend toward more scientific methods of selling personal planes is seen as a parallel to the highly developed sales programs which have been used by automobile distributors and dealers over a period of many years.

These sales programs have been responsible for a major part of the expansion of the family car market in the country to a point where immediately before the war 52,000,000 people in 15,000,000 automobiles spent $5,000,000,000 annually touring the country, and more than 360,000 establishments, such as dealerships, repair shops, and gasoline stations did an annual business of $8,500,000,000 with automobile owners.

In other industries training has increased the sales production of average salesmen 30-50 percent. In the case of a life insurance company employing 450 agents, the total production of the group was raised from $20,000,000 to $60,000,000 annually after training. The sales production of an electrical appliance manufacturer was trebled. A furnace manufacturer's sales doubled. Moreover, the records of the Chicago Milk Dealers' Assn. show that the benefits of sales training are cumulative. From a 3% increase in sales production the first month, sales volume of all salesmen of association members who took training increased to 19% by the end of six months. Similar results certainly should be obtained in the aviation industry.

Discharged military pilots and others are planning to establish airparks, flight strips, and commercial flying enterprises of all kinds, many in close proximity to existing airport service operations. This means that many of the established operators will be able to meet competition only as long as they are progressive and can continue to outsell their new neighbors.

Airport businesses have increased from 1,800 to 3,000 in the last six months, and industry leaders say there will be 10,000 in the near future. Most of them will offer a variety of services, including aircraft sales and service, storage, flight instruction, and charter and passenger flights. Specialization has been evident only in the larger communities where it can be justified by a sufficient volume of business. In any event, the operators who plan to sit and wait for business to come to them, as some have been able to do in the past, expectedly are due for some tough sledding to make ends meet.

Military aviation men, with their eyes on their own airport businesses, have been quick to realize that they may be good pilots or mechanics but in many cases are woefully short on sales and merchandising. That is why so many of them are going in for spare-time study of the Institute's general sales training program, "Developing Your Ability for Aviation Selling."

These Institute sales training courses grew from a realization that upon completion of its war job, aviation would perhaps be more seriously affected by contract cancellations than any other industry. It had comparatively few professional-type salesmen or sales outlets before the war. Also, airport service operations, the focal point of the manufacturers' contact with the public, would require training and help of every conceivable nature to achieve real results in marketing an ever-increasing volume of airplanes, accessories, and services. Very often has it been said in this industry, "Now take Joe So-and-So who runs the local airport—as a pilot you can't beat him, but he certainly is no salesman".

That is the situation we hoped in some measure to correct when the Institute was organized in 1943 as a division of Aviation Associates, primarily a market research and consulting firm. Having determined that aviation needed a sales training organization whose staff was familiar with the merchandising problems of the indus-

try, we set about to create two definite programs:

First, a correspondence course which operators could study at home during slack periods; and second, a program of personal training sessions expanding upon the home study materials and giving the dealers an opportunity to put their sales problems up for open discussion.

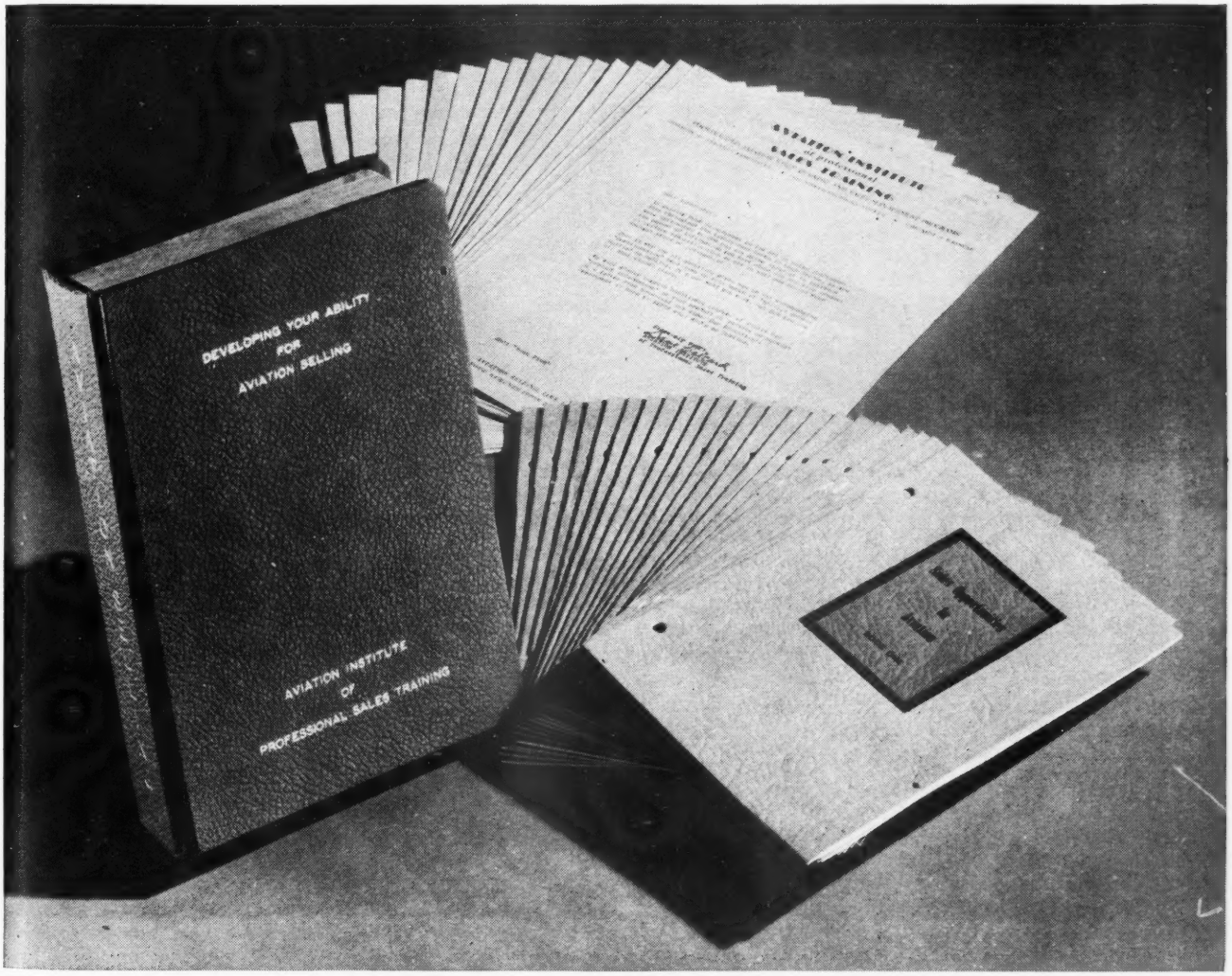
One thought has been paramount in our planning. It is that introductory aviation sales training programs should present only selling principles and techniques proved successful through the years by outstanding salesmen in other industries. These principles provide the foundation upon which all good selling is based, regardless of the product or service being marketed. To assist in building a course adaptable to all phases of the aviation industry, the Institute secured the services of David H. Colcord, nationally known sales training consultant, active salesman for 25 yr., and author of many textbooks on selling. During the past 15 yr. he has trained thousands of salesmen for such companies as Greyhound Bus Lines, Colgate-Palmolive-Peet, Square D Co., Iron Fireman Corp., and others.

The trend in progressive aviation sales management is to broaden the *base* of sales training courses, so as to include (1) more unselfish basic selling and less selfish product-puffing, (2) more sales technique and fewer product technicalities, and (3) training in how to sell *many* items in the distributor's stock—not merely one line. Particularly is this broader viewpoint important in the case of airport operators, who must sell airplanes, storage, service, flight instruction, charter and passenger flights, and many other products and services to make a success of their businesses.

The principles of salesmanship included in the texts of "Developing Your Ability for Aviation Selling" are equally applicable to all aviation products, accessories, or services which the airport operators and dealers may have to merchandise. Slanting of the material to the specific needs of individual companies is handled through special sets of "self-appraisal" questionnaires which accompany each of the 24 weekly lessons.

Designed as a correspondence course, it involves salesman participation through solution of problems involving principles outlined in the texts, and incorporated are three major divisions: Pre-planning the sales interview, dramatizing the interview, and developing sales personality.

In addition to the "big three" manufacturers, many individual subscriptions have been received from independent operators, military personnel, and others who are now engaged in, or are planning to enter, some phase of the industry. The list of subscribers includes presidents, sales managers, personnel directors, distributors, dealers, pilots, and repair station operators —indicating a growing awareness that improved selling methods will be not only an asset, but a necessity to meet competition in distribution of personal planes, parts and accessories, and services.



Home study salesmanship course prepared by Aviation Institute of Professional Sales Training and adopted for all sales personnel by Aeronca, Piper, and Taylorcraft, as well as individuals, presents basic principles of selling which are applicable not only for aircraft, but also for parts, accessories, and services.

FLOATPLANE BASES CUT EXPENSES AND TIME

Typical inexpensive single-landing float is adaptable either to constant-level or tidal operations for handling both floatplanes and small to medium sized amphibians. With landing area provided by nature, Author Cooke points out that many waterborne operations can be conducted with much less capital than is required for land-based business.

USE OF AIRCRAFT which can be flown on and off water is bound to increase tremendously as business and recreational flying expand in the coming years. It is not intended here to add to the many estimates already published as to how many of these aircraft may be in use five or ten years from now, but it can be said that an extensive expansion in the use of waterborne aircraft seems inevitable for four principal reasons:

1. The provision of a water flying base does not involve the heavy investments that are needed to acquire land for an airport, clear it, grade it, install runways and drainage systems and, especially important, to maintain the plant in efficient, safe condition after it has been completed. The high costs of landplane bases often constitute extreme financial burdens upon the community and in many instances have been prohibitive.

2. Suitable water flying areas already exist at or near the heart of almost every community and industrial or recreational areas to which people will want to fly. There are many thousands of these natural airports that can be put to almost immediate use.

3. Interest in water flying was increasing steadily before the war.

4. Aside from its high utility factor, water flying has attributes of fun and personal satisfaction that are unique in aviation.

It is in order, therefore, to consider the various factors involved in preparing and improving suitable facilities for handling water aircraft. There has been a vast amount of planning in regard to airports for land-based aircraft and there should be commensurate attention to arrangements for planes which can take advantage of what so often have been called "natural" landing places—lakes, rivers, and sheltered coves.

Because almost countless natural effective landing surfaces in the form of these lakes, rivers, and bays already exist—obviously without any grading, draining, runway, and other expensive preparations—and because of the low cost of providing basic handling facilities to be used in conjunction with

By **DONALD D. COOKE,** *Chairman, Seaplane Base Committee, Seaplane Flying Assn.*

Large investments are not always essential to successful operation. So says this seaplane proponent, who first cites advantages of "ready-made" landing areas, then presents a detailed checklist of the necessary "makin's", together with all the pertinent "how-to."

water areas, it may well be that in many areas top priority in development of aircraft bases should go to air harbors rather than airports. This applies to metropolitan areas (where close-in landing facilities are hard to locate unless advantage is taken of water areas) as well as to communities whose funds may be limited.

In any case, plans for aircraft bases in any community, large or small, are not complete unless they include maximum utilization of available water areas. Development of water flying will be fundamental to the practical application of non-scheduled aircraft to our economic and social life.

Classes and types of aircraft for which water bases are needed include: Conventional twin-float seaplanes which have always been the most popular and numerous; seaplanes having twin floats equipped with wheels to provide amphibious characteristics; boat type amphibians; and flying boats. For each type consideration must be given as to whether large as well as light aircraft are to be accommodated. It will be noted in the following that certain facilities are suitable for light water aircraft only.

The principal points to be considered in establishing a water aircraft facility are:

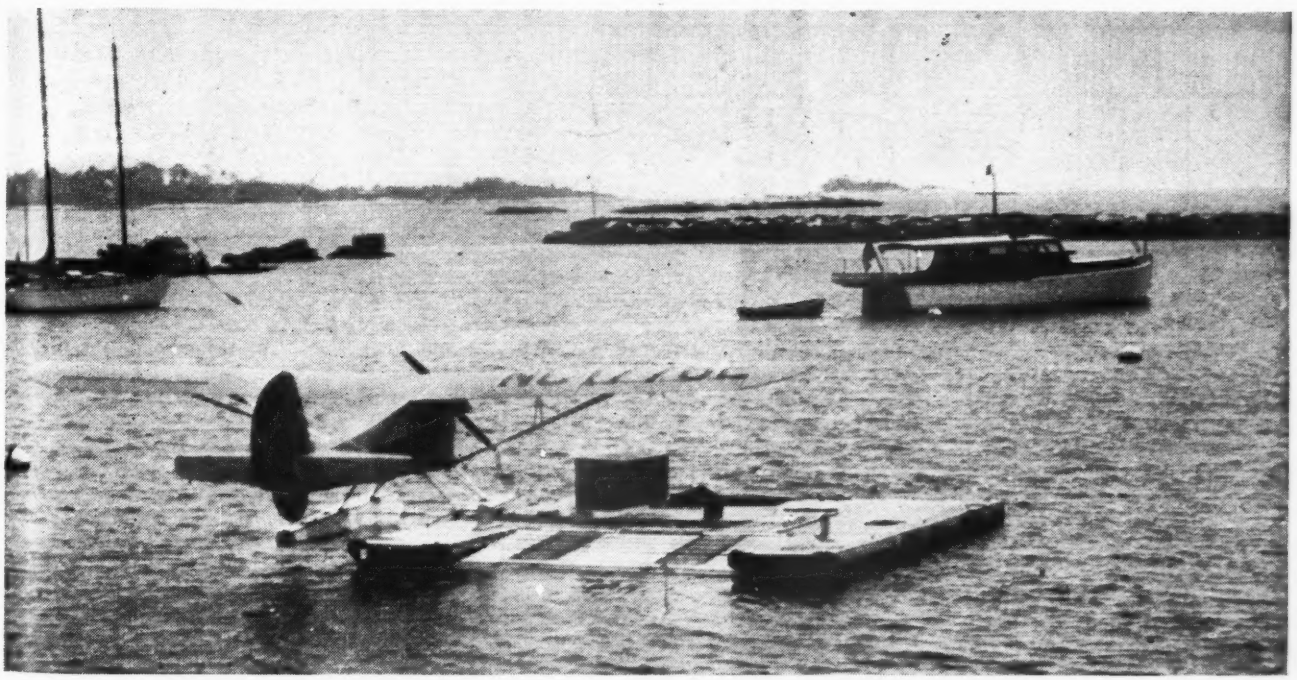
1. Types of installations for hauling water aircraft out of the water;
2. Various kinds of beaching gear for use with ramps;
3. Facilities for loading and discharging passengers; and
4. Water conditions affecting installations.

Types of Hauling-Out Facility

Fixed Ramp. Ramps laid on solid fill are highly satisfactory because they are less disturbed by ice conditions, although under certain circumstances the ramp-foot is sometimes difficult to keep clear of silt and sand if it rests on the bottom. Ramps should be surfaced with wood, because concrete will damage float keels, and they need to be somewhat wider (up to 50 percent) for hull type amphibians than for seaplanes because the amphibian usually is not as maneuverable on the water. The most satisfactory slope is about 1 to 9 and the minimum depth at the foot should be greater than the draft (with wheels down) of any amphibian the ramp might be called upon to handle.

Marine Railway. Main advantage of a marine railway is that it is in many cases less expensive to build and maintain than a ramp. It is less vulnerable to ice damage and no troubles are encountered with fouling of the surface with slime as in the case of the ramp. It is particularly suitable in areas of extreme tides and where the banks are excessively high, since the rails can be steeply sloped in order to shorten the length of the haul. Its disadvantages are that it can handle only float seaplanes (except in emergencies) and no one has yet built one which did not require an attendant on shore to assist in hauling an aircraft out.

The car of a marine railway should be constructed and the rails laid in such a way that the platform will have a maximum slope of 1 to 9 when partially submerged for taking on a plane and, further, will be level when at the top of the railway. Platform dimensions will vary, of course, with the size of the aircraft it is to handle. In the simplest cases, rails and cross ties can be laid directly on the bottom. A power winch is necessary for hauling the platform and, unless the rails are laid at a comparatively steep slope, the arrangement should allow the winch to



Floating ramp designed for lightplanes. Since ramp swings with wind, plane can be handled easier because it is always headed upwind toward base. Fuel and service equipment is stored in box seen under plane's wing.

haul the platform *down* as well as up.

Floating ramp. Three types of floating ramps have been built in recent years. The first was built into the side of an old Navy ammunition barge, the deck house installed on the barge being used as a hangar. A section was cut out of the side of the barge down to a point just above the waterline and a ramp built from there to the deck. The ramp was extended outboard to a foot or two below the surface of the water, and the entire side of the deck house on the ramp side of the barge was removed to allow sufficient room for moving planes about on the deck. That side of the roof was supported by a cable on the suspension bridge principle. A winch opposite the head of the ramp was available for hauling out, and a low float located near one end of the barge served for landing and taking on passengers.

This installation was used for a short time by a seaplane service operating from a pier in the Hudson River off Jersey City and was later operated as Sky Harbor on the New York side of the Hudson at 155th St. It served as a complete small base in locations where it was not possible to set up a permanent unit and had the advantage of being mobile as well as unaffected by variations in water level.

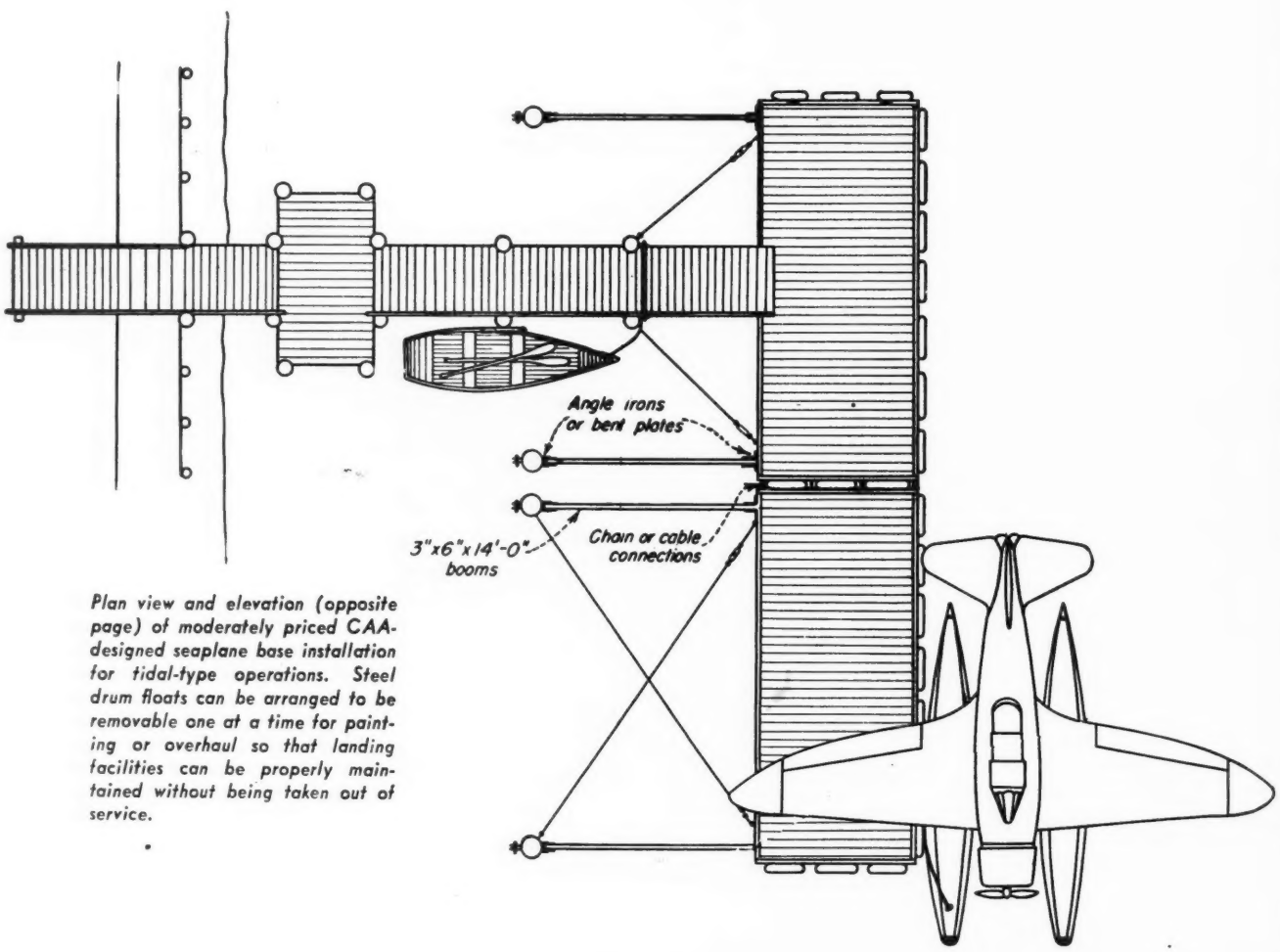
The second type was the turntable ramp, two of which were built for New York City and installed at 31st St., and at Wall St. on the East River. It was primarily developed for discharging and taking aboard passengers and for fueling both seaplanes and amphibians. While it was not so used in either of these installations, it can be operated in connection with storage and maintenance facilities. This type of ramp has a welded steel structure, surfaced with wood, and depends for flotation on tanks at the outboard and inboard ends and midway between. By means of compressed air, the amount of water in these tanks can be varied to change the slope. A power operated turntable is built into the lower center of the ramp. Fuel tank, pump, and hose are incorporated in the structure.

To receive a seaplane or flying boat, the outboard end is sunk until the waterline is at the turntable center and the ramp has a slope of about 1 to 8. The plane is grounded on the inboard half of the turntable disk and the ramp is then brought level by expelling water from the outboard tanks. The turntable is then rotated through 180 deg., and when the plane is ready to get away, the outboard end of the ramp is lowered until the aircraft floats or pulls itself off by its own power.

For an amphibian the procedure is the same. The plane is taxied onto the turntable with wheels down. The pilot holds the plane in position on the turntable with his brakes or engine until an attendant can block his wheels fore and aft for safety. The ramp is then leveled and the turntable rotated.

The ramp, fastened to a pier or bulkhead by booms and cross chains, is particularly valuable for use at the head of slips or channels where there is no room to maneuver planes on the water. The ramp permits the plane to come straight in, at some speed if necessary, and to be safely snubbed, turned around, and launched.

The third type of floating ramp is that built and used at Pine Orchard, Conn., by Franklin Farrell, Jr., and is suitable only for a float seaplane. It is a square float with an integral ramp. Fastened to a mooring, it is free to swing with the wind and, consequently, a plane can always be taxied directly up-wind onto the ramp. This means that the pilot can easily hit the slope accurately. Therefore, there need be



Plan view and elevation (opposite page) of moderately priced CAA-designed seaplane base installation for tidal-type operations. Steel drum floats can be arranged to be removable one at a time for painting or overhaul so that landing facilities can be properly maintained without being taken out of service.

little clearance between the floats and sides of the incline. For takeoff the plane is pushed overboard, stern first, and brought alongside where the pilot and passengers board it. Servicing and work on the plane can be done conveniently, for gasoline, oil, tools, and miscellaneous equipment can be kept in a locker on the float. Its usefulness, however, is limited to light seaplanes.

Beaching Gear

Two-Wheeled dolly for light seaplanes. This dolly, the original of which was built and used at Port Washington, consists of a pair of air wheels mounted on an axle shaped so that it lies close to the ground. Rectangular plates are welded to the axle at points the same distance apart as the float keels. A rigid handle, welded to the axle, projects outward at right angles similar to the tongue of a wagon. To put the dolly under a light seaplane, one man raises the tail to tilt the plane forward on the float keels, while another rolls the dolly under the aft end to balance the craft on the dolly so it can be pushed around by the tail.

Boston Dolly. This unit takes its name from the old Boston Municipal Airport where it was first built and where the hangars are a considerable distance from the ramp. It is a steel-framed structure with rectangular wooden platform and four pneumatic wheels, the front pair steerable. In operation, the dolly is rolled down the ramp until only the inboard edge of the platform is above water. The plane grounds on the dolly which is then hauled up the ramp by winch or tractor. With an attendant steering the dolly it can proceed from that point under the aircraft's own power. Disadvantages are the fact that the plane must remain on the dolly until it is put overboard again, and that a plane so situated occupies somewhat more space in a hangar than normally.

Christiansen Dolly. This type was an attempt to improve on the Boston Dolly by making it possible to pick up and deposit a seaplane while it is on land and thus require only one dolly for handling all planes. It consists of a rectangular steel frame hung close to the ground with four small pneumatic wheels mounted at each corner, the front pair steerable. Two steel channels, lined with wood to form a V-shaped depression in which the float keels rest, lie on the frame but are not fastened to it.

The plane is tipped back on its skeg castings and blocks placed under the keels at the bulkheads next forward of the skegs, then the craft is tipped forward and blocks placed under the skeg castings; this procedure is repeated until the blocking is 4 in. high under the skegs. With the plane tipped back, the dolly can then be wheeled into position, the channels placed under the keels and the ship allowed to tip forward onto the dolly. The blocks under the skegs are then loose. After moving the aircraft to its parking place, the blocks are placed under the skeg castings and the ship tipped back. The dolly can then be withdrawn and the ship allowed to settle down on blocks placed a few feet forward under the keels. From this position on blocks it is a simple matter to tip the ship back and put the dolly under it again.

Disadvantages are that this dolly requires at least two men, it must be taken out from under the plane by being rolled forward, and the plane must be set down high up on the ramp. There is also the fact that the ramp must be wide enough to permit the dolly to pass the plane when the former is pulled back up the ramp.

Edo Three-Wheeled Dolly. This type uses axle holes in the floats. Its frame is triangular with a wheel at each corner; the front one is steerable. Immediately forward of the two rear wheels are two prongs which are placed in the axle tubes to lift and support the plane. The dolly lies between the floats, the front wheel being just under the propeller hub. By means of a cranking arrangement near the front wheel, tread of rear wheels and distance between the prongs can be widened or narrowed. By another crank the prongs can be raised and lowered. An adjustable support bar is pinned over the front wheel and a steering and towing bar is fastened to the front wheel frame.

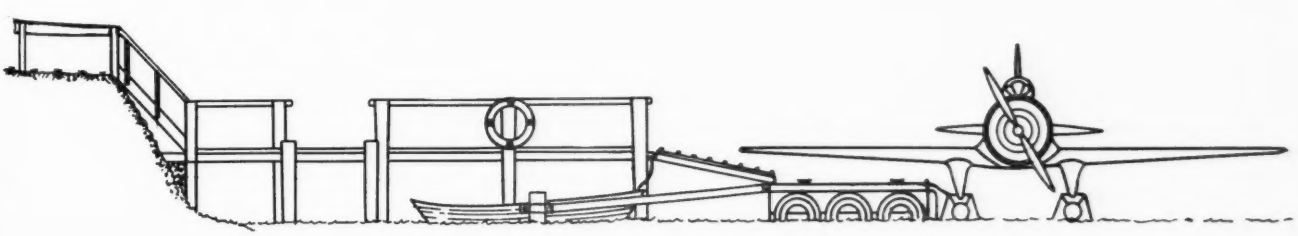
To pick up a plane, the dolly is rolled between the floats and the prongs cranked to the same height as the axle holes. The wheels are then cranked apart until the prongs enter the axle tubes and their shoulders butt solidly against them. The support bar is then extended up under the propeller hub and lashed to it. Finally, the prongs are cranked upward, lifting the plane a few inches off the ground, ready to be moved. Since the dolly has to pass under the spreader bars of the floats, the wheels must be comparatively small. Consequently, the surface over which they are to operate has to be relatively smooth. This dolly has the advantage of requiring only one man to operate it, and only one dolly per base is necessary.

Caster Dollies. These are individual units, one per float, having a rectangular steel frame with a small castering wheel at each corner. The end members are V-shaped and the float keels rest on them at the bottom of the V. To put a plane on this type, a telescoping lifting bar is placed between the axle tubes and a jack is used to lift first one float and then the other. The ends of the bar enter the axle tubes until the shoulders provided on the bar butt solidly against the tube ends. The clamp on the bar which holds it securely in this extended position is then tightened. A jack is placed under the bar close to the float chine and the float raised sufficiently for the dolly to be rolled under it. The float is then lowered to the dolly and the same process repeated on the other side.

Like the Edo dolly this type operates satisfactorily only on relatively hard, smooth surfaces and can be used only under floats having axle tubes. It requires only one man to operate and allows tight packing of planes in crowded or small hangars. It is desirable to have one pair of dollies available for each craft in active service, but one size dolly can be used under a wide range of sizes.

To give adequate and speedy service, the beaching gear should be supplemented by adequate passenger landing and refueling facilities which need not, however, involve tremendous investments. A low float probably offers the best arrangement for these operations if the plane is not to be taken out of the water.

The minimum practical size is approximately 22 x 10 ft. If more float capacity is needed, additional units can



be added. It should have splash boards on the front and sides, all faced with old automobile tires or other means of protecting floats or hulls from damage when they come alongside. Painters attached to cleats or ring bolts should be provided at several locations around the float. The float should be moored in such a way that no obstruction which might be fouled by wings or struts is within 20 or 25 ft. of the outboard edge of the float. This means that a float with a width of 10 ft. should be breasted out from piles or a pier by booms and cross chains to provide the necessary clearances. Access to the float is provided by a gangway.

However, if there is no appreciable rise or fall of tide, low piles could be adjacent to the float. The most satisfactory type float incorporates steel drums for flotation and is so constructed that the drums can be removed for painting or replacement, one at a time, through the deck while the float is in the water. An advantage of any float is that it can be hauled out in the winter.

Fixed Pier or Dock. Where the water level does not vary more than 2 ft., a low pier or dock is quite satisfactory and inexpensive. It should be not less than 2½ ft. wide and should be built in the shape of an L or T. The piles are to be cut off so that they extend no more than 4 in. above the deck. The outboard face should be protected with tires or other bumpers as in the case of the float. In one case where quiet water was the rule, horizontal stringers placed along the face on 2 x 4s nailed vertically every 3 ft. served very well. A light dock must, of course, be taken up before ice forms in the winter and put down again in the spring; but this is not a difficult job.

Moorings. One or two moorings are indispensible at any base, whether or not it has hauling-out facilities. Where the bottom is sand or mud, a 100-lb. mushroom anchor, and a sponge rubber or cork buoy connected by chain and tarred rope are ideal.

Tender. Every base should be provided with some sort of tender. If a plane goes adrift or its engine stalls or fails to start, a boat is essential. In most instances a row boat or skiff is satisfactory. In rare cases a power boat might serve better; but when such a craft is needed in a hurry, time may be wasted in starting its engine and there is always the danger of serious damage from collision, especially if it is being operated by an attendant of questionable skill.

Servicing. Buried fuel tank, power pump, and hoses at ramp, hangar, and float are, of course, most desirable. Where such an elaborate installation is not feasible, a wheeled tank with hand pump and a long hose will serve.

Conditions Affecting Installations

Where the water level is constant, as in a dammed up lake, water aircraft base problems are simplest. A ramp or railway can be of minimum length and a simple pier or dock, or perhaps even a bulkheaded beach, will serve for a passenger landing facility. The problems are still comparatively simple where the rise and fall of the tide is less than 2 ft., as at certain locations on salt water on the eastern seaboard. Where the variation in water level becomes large, however, the problems become more difficult, at least as far as the hauling-out facility is concerned.

Often a marine railway is the only really satisfactory solution. In latitudes where ice conditions are encountered, floats or light piers must be taken up and ramps or railways must either be laid on solid fill or built of heavy enough construction to stand up. Railways have advantages in this respect since they offer much less than a ramp for the winter ice to get a hold on.

Installations in rivers having an appreciable current as well as a variation in water level require special treatment. Often some type of floating ramp facing down stream is necessary. Any base should be located so that there is protection against rough water and wind and yet enough water area for maneuvering, free of small boat congestion. A 3-ft. depth of water is sufficient except for large aircraft; perhaps less is required for bases designed to handle only lightplanes.

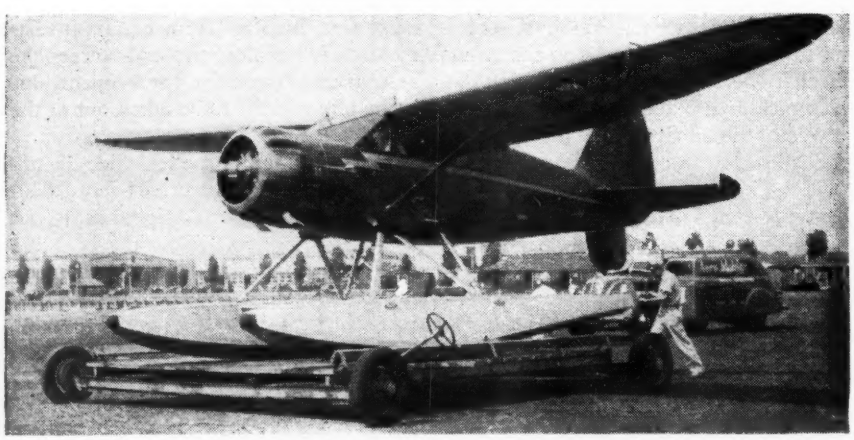
Because seaplanes fitted with conventional (that is, non-amphibious) twin-floats were the most widely used of all water flying equipment preceding the war, the emphasis naturally was on the development of facilities best adaptable to handling and servicing that type. The flying boat was practically extinct, except for the big ocean airliners, and the small amphibian was represented by only a few deluxe types.

The emphasis may change, if small amphibians or planes on amphibious floats become more popular, but only to the extent that in most instances ramps may be more suitable than marine railways. While a boat type amphibian can be handled on a marine railway, it is usually done only in emergencies, and ramps obviously have the advantage in that wheel-equipped aircraft can be beached quickly and easily under their own power.

In summary, a complete seaplane base, private or commercial, consists of a small boat, one or more moorings, a float or pier, a facility by which the aircraft may be taxied out of the water or be hauled out, a hangar, and gasoline tank and pump. The principal differences between a private and commercial base would be the number of moorings, size of floats and hangar, and the provision of a hard surfaced area between the hauling-out facility and the hangar for parking aircraft.

The gasoline system, incidentally, should be arranged so that planes can be fueled at either float or hangar. It is important to remember, however, that a practical base may consist of as little as a float or pier, to which can be added, as desired, fueling facilities, a mooring, and a small boat. It is important to note, also, that a seaplane can be moored safely out in the open, if properly secured, in most storms of less than hurricane intensity.

There are two distinct advantages for the development of bases for water aircraft. They can, in most instances, be built by local labor of average skill with materials locally obtainable, and plans for use in the construction of different types of equipment are available without charge.



Boston dolly for beaching medium-sized floatplanes. Equipped with steerable front wheels and brakes, this type has been found very flexible in getting floatplanes in and out of water.

TAGGING THE BASES

Ex-G. I. Mechanics Topnotch

After experiencing considerable tribulation because of the wartime civil mechanic shortage, Bill Ong of Kansas City hired three discharged AAF ground force men. This is what he says about the men, after three months' experience:

"We certainly are pleased with them and with the way they turn out the work. These fellows had been working under enemy fire without proper equipment, and have had to use their ingenuity to the fullest extent. They have a very fine attitude, are cheerful, anxious to get ahead, and are really refreshing to work with."

With the present increase in the number of small airports, there should be plenty of jobs for ex-Army men who have had diversified experience both with work on aircraft and with airplane engine maintenance.

First Region—Smithfield, R. I., Airport has re-opened for civilian flying and held first air meet in four years on Nov. 4. Featured were parachute jumps, spot landing, and aerobatics. . . . Meltz Aircraft, New Brunswick, N. J., has started distribution business under Capt. J. R. Petronis and Lt. J. W. Penka, both ex-AAF. . . . Burlington, Vt., Airport is now being operated by Dan Hufnail, former Chance Vought test pilot. . . . Otto Aviation, Bloomfield, N. J., has been appointed Aeronca distributor for N. J., and Monroe Co., Pa.

Second Region—Aviation Sales & Equipment of Coconut Grove, Fla., has opened engine and airplane surplus parts business with large stock. . . . Gil-Dove Airways, Martin, Tenn., operated by Gil Staulcup, Taylorcraft agent, has added a complete set of new buildings to field. . . . Louisville's Kentucky Air Transport, run by J. B. Walthen and Carl Ulrich, has been appointed Taylorcraft distributor for most of Ky. and nearby counties in Ill. . . . Paul L. Cromelin, Augusta, Ga., Airport manager, is distributing Culvers in Ga., West N. C., and S. C. . . . News is that Southern Airways is observing its 16th anniversary. Operations include fields at Birmingham, Decatur, and Huntsville, Ala.; Camden and Greenville, S. C., and Charlotte, N. C., in addition to headquarters at Atlanta, Ga., where SA has built a hangar with 38,000 sq.ft. floor space, said to be largest constructed by any fixed bases.

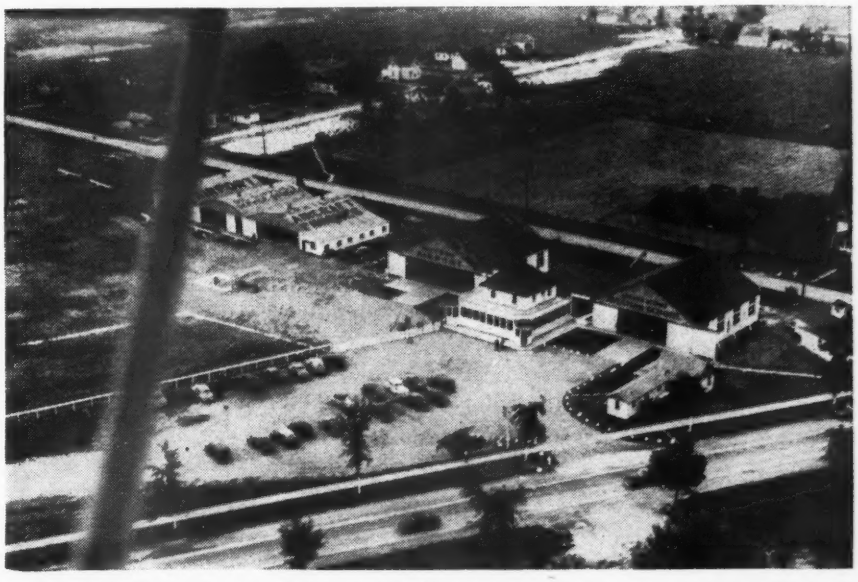
Third Region—Greater Detroit Airport, Globe and Republic agent, is now operating a fleet of 15 Piper Cubs for flight training. . . . Cavu Aircraft at Lunken Airport, Cincinnati, has dealership for Globe and Ercoupe. . . . Parks Aircraft of East St. Louis, Ill., Ercoupe distributor, is handling sales of Bendix Flightweight lightplane radio in Ill., Ind., Mo., Kan., Ia., and North Ohio. . . . Michigan Dept. of Aeronautics makes point of asking that any stolen aircraft be reported immediately, because McCarran Bill now makes theft of aircraft federal offense.

Fourth Region—Tom Black, formerly pres. of 1st Nat'l Bank of Higgins, Tex., who learned to fly at 61, now has airports at Ft. Worth, Waco, and Hamilton, and he is Taylorcraft distributor for that territory. . . . Otis Edgerton of Alexandria, La., Airport is Culver distributor for that State, also Miss. and South Ark. . . . Wood Breazeale of Pelican Aviation, New Orleans, La., who had to postpone field dedication because of high water last Spring, reports that sales and instruction are good.

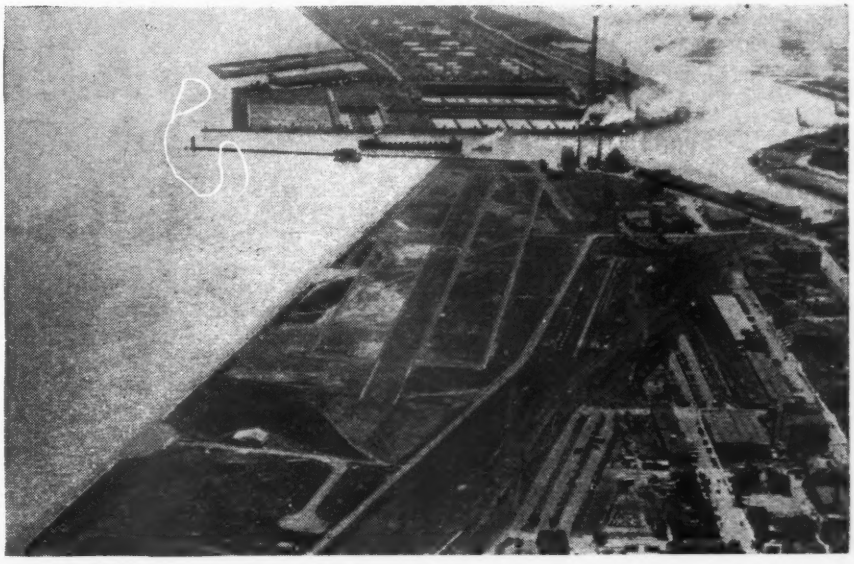
Fifth Region—Edward Anderson's Airport at Mitchell, S. D., is now service center for this district, which formerly lacked such facilities. . . . Corydon, Iowa, reports that a certain local big shot refused free sample flight offered by Earl Ehl, Taylorcraft agent, "because I might like it!" . . . Norman Kramer of Alamosa, Colo., Flying Service, has had a contract for past four years with State Game & Fish Commission, counting big game from air. . . . Johnson's Flying Service, Missoula, Mont., will fly twice monthly during winter carrying supplies to snowbound Deadwood Dam, Ida. Pilots Bill Yabey and Bob Fogg will do job.

Sixth Region—Escondido, Calif., Airport, Engel Aircraft Specialties operated, has now been opened for civilian use . . . M. N. Gustavon, Taylorcraft dealer at Alturas, Calif., reports that "Sagehoppers," aviation recreation club for personnel from Fallon Navy Base, now has membership of 122. Clubsters call small planes "Hellkittens." . . . Alton Walker, Monterey, Calif., and Kidwell & Royster, Los Angeles, now have Culver agencies for N. and S. parts of state, respectively.

Seventh Region—Chennault Flying Club of Eugene, Ore., now has 21 members and 2 planes, with paid in capital of $7,000, reports Portland *Oregonian*. . . . Hockensmith & Ott of Portland, Ore., is now Culver distributor for Wash. and Ore. . . . Fairchild distributor for Wash. and Ore. is Pacific Aircraft Co., Fresno, Calif. . . . Warren & Day, Studebaker agency in San Bernardino, Calif., has taken the Taylorcraft dealership for that district, manufacturer announces.



Greater Detroit Airport, operated by T. MacDonald, who has had many years in automotive supply field. Aim is to offer service and maintenance on same basis as in auto business. Company is Piper, Globe, and Republic agent.



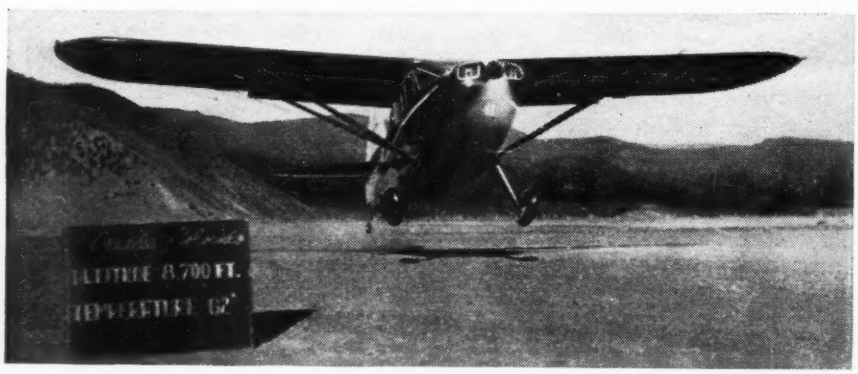
New Milwaukee municipal landing strip, 3,000 ft. long, is only 5 min. walk from business section. Shown at bottom left is seadrome of Lange Aviation Corp., which supplies full service and overhaul facilities, together with ample hangar storage space. In addition, Lange also has agency for speed boats and marine engines and marine supplies.

FLYING EQUIPMENT

New Voyager 150 Four-Placer Delivered by Stinson

Higher-powered craft is development of earlier 125-hp. Voyager, with further refinements including new tail assembly.

New Stinson Voyager 150 shows neat flight lines. Selling at $5,000, plane is now in large scale production set at 3,500 units for this year and next. At 2,105 lb. gross weight, craft has 133-mph. top speed and range of 500 mi. Wings are fitted with fixed slots and large flaps.



Craft's high altitude performance was demonstrated at loftiest designated CAA field in this country, at Creede, Colo. It is stated that comparatively short takeoffs were achieved.

A NEW, FASTER, and more powerful Stinson four-place personal plane, the Voyager 150, is now being delivered, with more than $7,000,000 in customer orders banked against scheduled production of 3,500 planes of this type in 1945 and 1946.

Tagged at $5,000, the new craft succeeds the Voyager 125, and though very similar in layout, it incorporates many improved features as a result of experience with the former model. Featured is a new all-metal tail which gives increased maneuverability. A 150-hp. 6-cyl. horizontally-opposed Franklin is stated to provide a top speed of 133 mph. and a 125-mph. cruising speed. A 40-gal. fuel capacity permits a 500-mi. range, and service ceiling is put at 14,000 ft.

Span is 34 ft., length 23½ ft., gross weight 2,105 lb., weight empty 1,206 lb., and useful load is given as 944 lb. At sea level, takeoff distance is placed at 550 ft., and landing roll at 230 ft. During a series of tests at the highest CAA designated airport in the U.S.—a field at Creede, Colo., 8,700 ft. above sea level—the new Voyager 150 is stated to have been airborne after a relatively short run. Other trials included flights over the Continental Divide as a further measure of the craft's performance.

It is stated that wing slots make the Voyager 150 spin resistant, and improved brakes assure greater landing safety. Among major assemblies in production by Stinson at Nashville, Tenn., are the fuselage, landing gear, and motor mounts. Company's main plant is at Wayne, Mich.

Specifications and Data

Span	34 ft.
Length	23 ft. 6 in.
Gross weight	2,150 lb.
Empty weight	1,206 lb.
Useful load	944 lb.
Top speed	133 mph.
Cruising speed	125 mph.
Rate of climb	770 fpm.
Service ceiling	14,000 ft.
Fuel capacity	40 gal.
Range	500 mi.
Takeoff distance (sea level)	550 ft.
Landing roll (sea level)	230 ft.
Seating	4
Power plant	150-hp. Franklin
Price	$5,000

Here's Bumblebee Powered-Soarer

Mounting small "kicker" which dispenses with need for towing equipment, this Nelson Aircraft auxiliary-glider is capable of making short powered flights. Featuring retractable tricycle landing gear and internally expanding brakes, craft is designed to sell for under $1,000 in kit form.

DESIGNED ESPECIALLY for the soaring sportman, a new two-place auxiliary-powered glider is now undergoing flight tests by Nelson Aircraft Co., San Fernando, Calif. Head of the new company is Ted Nelson, veteran glider enthusiast, and vice-pres. is the well known William Hawley Bowlus, who designed the craft.

Dubbed the Bumblebee, the design is entirely of plywood construction except for the hollow dural tail boom. A molded shell comprises the pilots' nacelle, and it is fitted with a Plexiglas bubble type canopy for maximum visibility. Instrument panel contains conventional throttle, choke, mixture controls, altimeter, and airspeed and rate of climb indicators. There is also a magneto ignition with impulse starter so that the 16-hp. Righter engine cannot at any time backfire, and there is a ratchet-wire starter mounted on the crankshaft enabling either pilot to stop or start the engine. The engine is a 4-cyl. opposed 2-cycle type developing maximum horsepower at 3,500 rpm.

An unusual feature of the Bumblebee is its manually operated fully retractable tricycle landing gear, with steerable nose wheel fitted with minature shimmy dampers. Both rear wheels have special cam action so that they fold into the fuselage at the proper angle. They also have independent, internally expanding brakes, designed by Bowlus to faciliate taxiing. A conventional glider hook is fitted to the craft's nose.

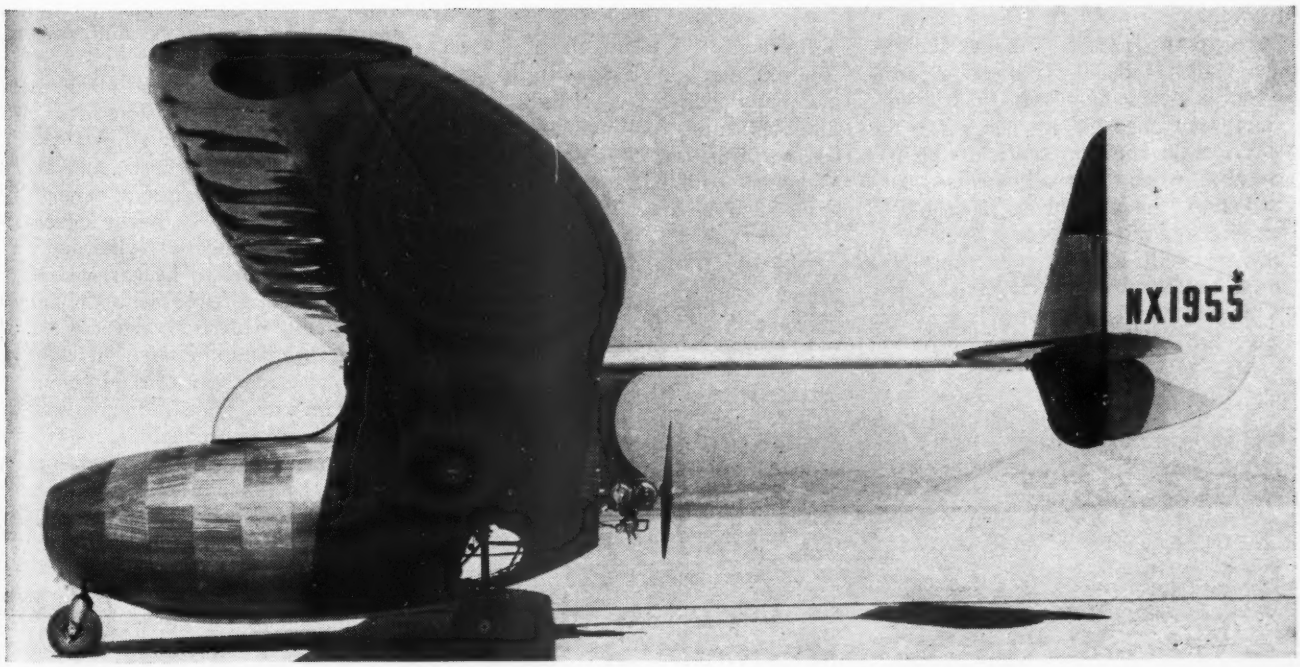
Wing span is given as 47 ft., and wing area as 168 sq. ft. Overall length is 23 ft., height 5 ft., and weight empty 465 lb.; while 350 lb. are allowed for two passengers. Horizontal tail surfaces have an area of 16 sq. ft., while vertical surfaces are 12 sq. ft. With 3-gal. fuel capacity, craft is stated to have a 1½ hr. cruising range at full throttle, and it will cruise at 75 mph. On takeoff it will climb at an estimated 38 mph. to an altitude suitable for soaring. The prototype was flown with a wood propeller, but later models are to have adjustable pitch propellers.

It is stated that the Bumblebee will sell for well under $1,000 in kit form, and that anyone wishing to purchase the glider without engine will be able to do so, it being replaced by a weight to insure balance.

Minimum storage and maintenance are claimed. Wings and tail surfaces are removable, and the glider may be hauled on a trailer by car. It is estimated that within six months production facilities will be ready to turn out the Bumblebee in kit, semi-finished, or finished form.

Specifications and Data

Span	47 ft.
Length	23 ft.
Height	5 ft.
Wing area	168 sq. ft
Weight empty	465 lb.
Gross weight	815 lb.
Cruising speed	75 mph.
Rate of climb (takeoff)	about 300 fpm.
Fuel capacity	3 gal.
Seating	2
Power plant	16-hp. Righter
Price	under $1,000



Designed as an auxiliary soaring glider, new Nelson Bumblebee also will enable short powered trips from airport to airport. Righter 4-cyl. 16-hp. engine, mounted beneath tail boom, is primarily intended to get soarer up to favorable altitudes without necessity for tow.

CULVER TESTING SPEEDY NEW MODEL V

Culver's new Model V side-by-side two-placer embodies developments achieved during company's wartime production of radio-controlled light craft, with many refinements added for personal flyer.

Of all-wood stressed skin construction, craft has an 85-hp. Continental engine enclosed in a very compact cowling, which together with large expanse of transparency makes for fine visibility.

Company states that Continental-powered all-wood two-placer, soon to be in dealers hands, combines high speeds with spin-and-stall-proof safety features.

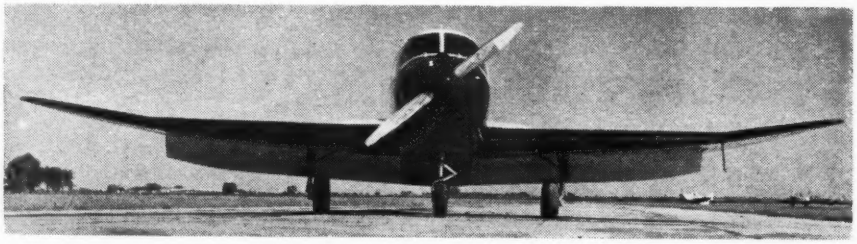
CULVER'S LATEST personal plane is the Model V, a high performance side-by-side two-placer now being put through its paces for the CAA at the company's Wichita plant.

Of all-wood externally stressed construction, the new plane incorporates an electrically-retractable tricycle landing gear with Mooney power unit, plus auxiliary manual control, and a new Culver simplified control designed to give the craft inherent trim for best performance. It entails the basic interconnection of wing flaps with the stabilizer, and included is a flight control dial indicating optimum setting for best performance. It is stated that such a control eliminates the hazards of cross-wind landings and also renders craft incapable of spin or stall.

Although complete performance figures are not yet known, the craft will have a guaranteed range of over 700 mi. using a Continental fuel-injection engine of 85 hp. It is stated the Model V will be faster than the prewar Culver, which had a 120-mph. cruising speed on a 75-hp. engine. Payload of the new plane is given as 80 lb. of baggage, 35 gal. of gas, plus pilot, passenger, oil, parachutes, and essential flight instruments.

Other features include full flaps, factory built-in provisions for two-way radio, individually adjustable Airfoam seats, larger wheels, and also a wide, de luxe soundproof cabin with convenient entry. A newly developed Goodyear gas tank of Nylon and rubber permits fuel to be carried in the wing's leading edge without danger due to wing deflection, and it is said to insure minimum change in trim as fuel is consumed out of the two tanks.

A great deal of experience was obtained in mass producing this type of craft during the war, since the company was the prime contractor for the services for radio-controlled target airplanes of much the same layout as the new Model V. Several thousand of these pilotless craft were supplied, ranging up to 150 hp. The company states that demonstrators of the new models will be delivered to dealers in early 1946.



Exact front view of Culver with wing flaps down to show large braking area. Company states that new craft is fastest personal plane in world for given power. Tricycle landing gear is electrically retractable.

Globe Mass-Producing Metal Side-By-Side Swift

Fast new craft features hydraulically retractable landing gear and de luxe cabin appointments. Segmented construction has been designed for ease of repair and maintenance.

PRODUCTION of the new model Swift is already well under way at Globe Aircraft's Fort Worth plant, and plans call for delivery of 4,000 of these all-metal side-by-side two seaters by the end of 1946. The company reports a backlog of over $10,000,000 in orders.

It is stated that about 3,600 tools and fixtures are required for turning out the Swift. The craft's semimonocoque segmented wings consist of center section, outer panels, tips, slats, ailerons, and flaps, with all components easily detachable for ease of repair or maintenance. The center section is attached to the fuselage by main and rear spar attachments. Gas tanks, of 15-gal. capacity each, are fitted in center section rib apertures, with the fuel feeding into a common trap on the craft's centerline, permitting constant lateral trim. Outer wing panels are attached by three bolts (two at the main spar and one at the rear spar), and outer panel skins are beaded for added strength. Slotted-type all-metal flaps are statically and dynamically balanced.

Composed of a forward and rear section, the fuselage is of conventional semi-monocoque construction. Cabin enclosure is a sliding, transparent panel disappearing into the fuselage walls, and it is easily opened at any speed in flight. Empennage is a mono-spar structure with Frize-type elevators. Leading edge ribs are formed of blanked sheet skin riveted to spars and skin. Trailing edges are formed strips. The left elevator has a trim tab fastened to an auxiliary spar forward of the trailing edge.

A wheel and suspended pedal type control system is used, with elevators actuated by cables attached to the wheel and to a quadrant in the fuselage rear. From this point, push-pull tubes connect to the elevator control horns. A sprocket-driven chain from the control column is connected to control cables (supported by pulleys) and run aft and then outward to the aileron bell crank. Rudder control consists of two line assemblies connected to the pedals. From the link assemblies, cables are connected to a quadrant below the cockpit floor. Control cables are attached to the quadrant and extend aft through the fuselage, guided and supported by pulleys to the rudder control horn. Each control surface is hinged entirely by ball bearings.

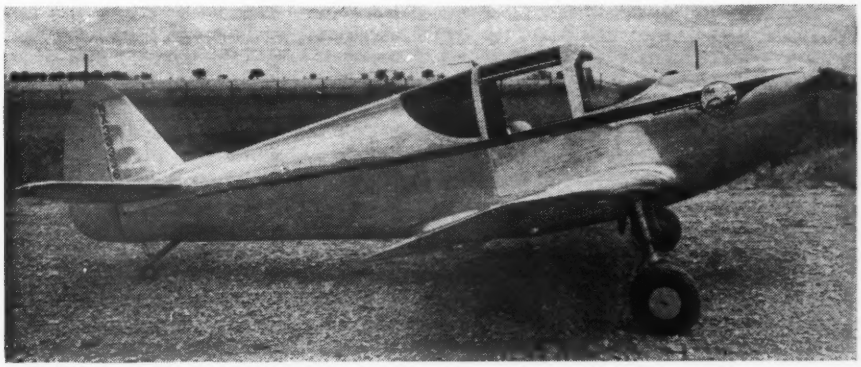
The 12v. electrical system includes a spill-proof battery, engine-driven generator, and avigation or position lights. Landing gear and flaps are actuated by a hydraulic system. All gear operations are stated to be positive, with down and up locks for the gear. Flaps may be stopped in any intermediary position. An emergency hand system for landing gear operation is included. Lights on the instrument panel indicate landing gear position, being directly wired to the master switch.

Landing gear shock is absorbed through full-size oleo spring struts having a 3½ in. travel. Shear-web type nose ribs are used in the landing gear attachment area forward of the main center section spar, with two auxiliary shear beams between two ribs, forming a rugged torque box for attachment. Tail wheel has a hydraulic springstrut and is steerable through 90 deg.

Power plant may be a 4-cyl. 85-hp. Continental, or 6-cyl. 125-hp. Continental, with either engine using carburetion or fuel injection. Starter, generator, and two fuel pumps are attached. The top half of the engine cowl is removable by loosening two Dzus fasteners and lifting handles on the cowl front. The lower half is attached to the fuselage by four bolts.

Cabin width is given as 42 in. Seats and one-piece back are foam-rubber cushioned. Upholstery is leather, and there is an ash tray and map pocket on each side of the cabin. Soundproofing consists of insulation more than ½ in. thick, covering the firewall, entire floor, and the side panels from firewall to aft end of the baggage compartment. The floor is completely covered by a felt rug.

Wingspan is 29 ft. 4 in. and landing gear tread 9 ft. 9 in. Cruising speed is given as 125 mph., landing speed as about 42–45 mph., and cruising range 6 hr. Rate of climb is stated to be about 750 fpm. at approximately 80 mph. With about a 12 mph. headwind, the craft is stated to take off in 550 ft.



New Globe Swift, now in quantity production, is stated to have a 125-mph. cruising speed and a 6-hr. range. Power plant may be either 85-hp. or 125-hp. Continental. All-metal semi-monocoque construction is used. Note elevator-stabilizer dihedral.

MILITARY

Firebrand and Lincoln "Up" RAF Might

Former is Blackburn's versatile single-place carrier-borne fighter or torpedo dropper fitted with interesting wing-folding mechanism and adjustable missile carrier—while latter is Avro's newest heavyweight, unveiling suped-up firepower and long-range features.

TWO NEW BRITISH WARCRAFT, the Blackburn Firebrand T. F. IV torpedo-fighter and the Avro Lincoln heavy bomber I and II, were being delivered for combat when the Pacific war ended. The Firebrand is a single-place carrier-based craft armed with four 20-mm. Hispano wing cannon, and it is powered by a 2,500-hp. Bristol Centaurus 18-cyl. radial turning a four-blade Rotol prop. The seven-place Lincoln (Page 164, July AVIATION), powered by four 1,750-hp. Rolls-Royce Merlins, is actually a scaled-up Lancaster, initially intended to haul the RAF 11-ton bomb against Japanese targets.

Blackburn Firebrand T.F. IV

Fuselage is made in two sections, joined at a bulkhead behind the pilot. Engine mount and cockpit is a tubular framework assembled on a chassis of extruded channel section members braced by channel members and plating, covered by metal skin and detachable side cowlings. Rear fuselage is of monocoque design, with an access door beneath and just behind the cockpit.

Center section is attached to fuselage longitudinal members at joints on front and rear main girders. An oil cooler is fitted in the starboard leading edge, and a carburetor air intake on the port. All hydraulic equipment, mounted below the fuselage in the center section, is stated to be fully accessible through the landing gear compartments.

Wings are of the folding type, hinge lines being so arranged that the wings are brought into a position parallel to the fuselage. Large-chord slotted flaps are hydraulically operated and are mounted on rails completely enclosed in the wing section. An auxiliary split flap in the trailing edge of the main flaps opens automatically when the main flaps are lowered. Dive brakes fitted to both upper and lower wing surfaces limit the craft's diving speed to about 350 mph.

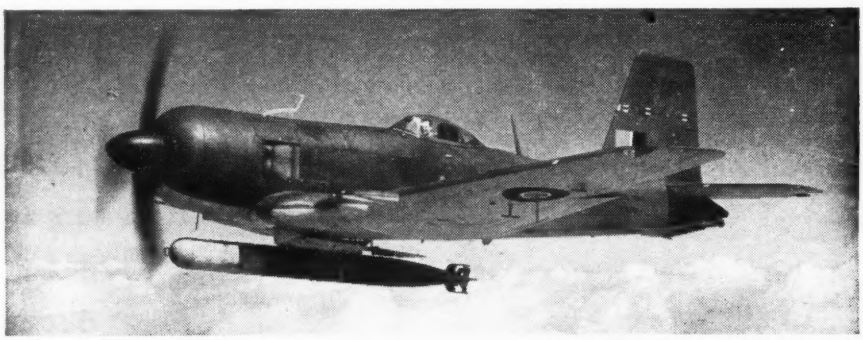
Medium-pressure wheels are fitted to Lockheed oleo legs which, driven by engine-driven pump, are said to retract completely within 3 sec. Pneumatic brakes are operated by a lever on the control column. The oleo-pneumatic tail wheel unit is fully castering, self-centering, and fully retractable.

Controls utilize a certain amout of aerodynamic balance of inset hinge type coupled with spring tab controls. Ailerons are operated by chains and sprockets to a lever on the center section girder and thence by tubes to the surfaces. The elevator control system consists of a tube from the foot of the column operating to a chain and sprocket drive at the bulkhead behind the pilot, and from there by push-pull rods. Rudder is operated by tie rods with chains and sprockets to the same bulkhead.

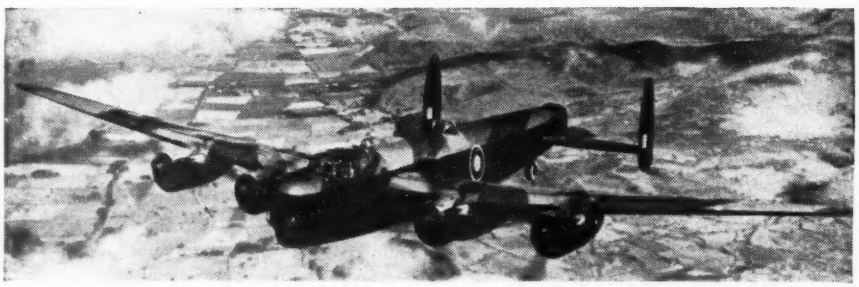
Gun compartments are heated by air ducts from a muff fitted to one of the engine exhaust pipes. Each gun has a hinged mount attached to the front main spar, permitting the guns to be swung down and giving access to the breeches. After servicing, the guns are swung back into place where they are retained by a spring-loaded catch. A specially-designed bomb and torpedo carrier is set below the center section, and is movable to permit variation of the angle relative to the direction of flight. This is done by an automatically-controlled hydraulic inter-connection with the landing gear system. It is stated that an advantage of this idea is that the torpedo may be dropped at greater speeds than formerly.

To fold the wings, latch pins are withdrawn from wing girder sockets by

(*Turn to page 275*)



Shown here carrying torpedo, single-place Blackburn Firebrand T.F. IV is latest development of series of which first types were fitted with in-line Napier Sabre engines. A top speed of 342 mph. at 10,000 ft. is claimed for this version carrying full military load.



Avro Lincoln heavy bomber appeared too late to help pulverize Japs with RAF's 11-ton "earthquake" bomb. Powered by four 1,750-hp. R-R Merlins in new circular-type cowlings, craft has 120 ft. span but retains many of famed Lanc's features. Innovations include use of .50-cal. machine guns. (British Combine photo)

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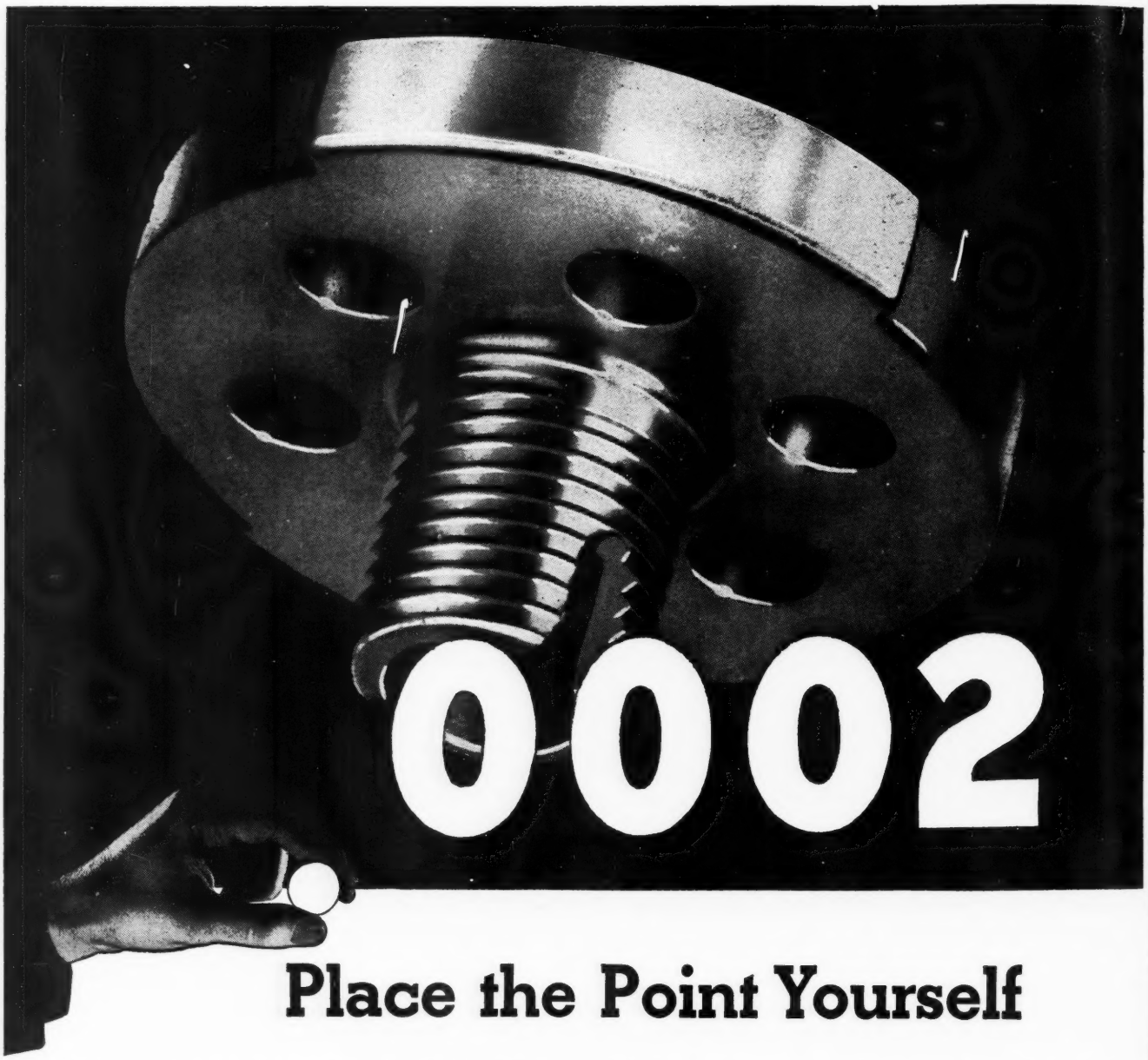

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Consairway War Experience Sharpens Convair Peace Designs*

By JAMES B. REA, *Engineering Test Pilot & Design Specialist, Flight Research Dept., Consolidated Vultee Aircraft Corp.*

Like Kipling's East and West, manufacture is manufacture and operations are operations. But these "twain" did meet when Consolidated Vultee launched Consairway—and today the many values realized by this wartime combination are proving a cogent influence in Convair's design of new air transports.

UNIQUELY, Consolidated's wartime operation of Consairway—long-range over-ocean military air transport line—saw transport-aircraft manufacture and transport-aircraft operation combined under one prime organization. And this mating proved notable in providing distinct advantages to both.

Consairway gave Convair the broad means of testing its craft and components in the most exacting of operations, thus directly integrating Convair design improvements; and conversely, Convair gave Consairway the many benefits of close association with the factory. The two "clicked" as a team.

This combination was, of course, dictated by the needs of war. But the comprehensive experience thus derived is now aiding in the designing for peace—by pointing up the features the peacetime air transport must have, together with the ways it can get them.

First a few words about the Consairway operation: Initially authorized in April 1942 to proceed with plans for a California-Australia line, it quickly required a program of Liberator conversions to accommodate cargo and passengers. Then with increased operations, a separate maintenance department, divorced from the factory service department, was required. Notable was the increase in engine utilization—up to 750 hr. before major overhaul. Contributory were such factors as rubberized ignition leads, metallized cylinders, weatherproofing of propeller governors, employment of flexible exhaust stack supports using the Lord-mount principle, also Lord-mounting of carburetor heat motors. To save time and costs, parts were pre-kitted prior to final engine assembly.

Further credit for high utilization went to systematic servicing and maintenance, with 100-hr., 500-hr., 1,000-hr., and 2,000 hr. checks prescribed. All such maintenance was primarily preventive. Propellers were kept in action as long as 1,750 hr. before change.

Thus airplane utilization rose from but a few hours per day at the start to more than 13 hr. daily in the last year of the war. Ton-miles delivered per month steadily increased from 26,189 per plane in Apr. 1942 to 259,300 when the war rounded off—nearly a 1,000% jump. Much of the high ton-mile performance can be attributed to high block speed.

Notable, too, was the safety record, showing 2½ yr. without a single fire in flight and but one serious accident, the latter entirely attributable to pilot error. As further proof, landings were consistently made with perfect safety at speeds far in excess of the old CAA maximum. Indeed, landing speeds of 100 mph. and higher were routine.

Convair-Consairway Advantages

Facilities of the manufacturers' flight research department were made available to Consairway for accurate de-

Builder becomes operator. Here, varied cargo—ranging from bulky engine nacelles to delicate radio instruments—goes aboard one of Consairway's Convair-made C-87s for quick whisk to South Pacific bases.

* From paper delivered by author before Society of Automotive Engineers.

termination of flight characteristics, performance, and cruise control information. The development engineering and production engineering departments at the factory have assisted in conversion problems, and helped to establish improved maintenance design. The manufacturer's operations and cost analysis groups have suggested to Consairway improvements in operating technique.

Many of the Consairway operations personnel had formerly been directly connected with shakedown flight testing, research flight testing, development engineering, or production engineering; thus, they were far more familiar with their equipment than most operations personnel. Direct association with the factory resulted in the slashing of the red-tape usually faced when operations information is requested, and because of this, detail design improvements were made available before routine release. In addition, spare parts required by Consairway were easily obtained from the factory as well as from the factory-supplied maintenance and service depots at the various military stations throughout the Pacific. Thus Consairway benefited by its inter-departmental association with the manufacturer.

Many Consairway personnel had formerly helped develop, produce, or flight-test craft employed, hence they had extraordinary familiarity with equipment and better perspectives of its needs. Photo shows chief flight engineer sampling oil following 100-hr. check by maintenance department.

Nine-Point Check

On the other hand, Convair design benefited by direct association with Consairway—for many reasons. Consairway provided a "proving ground in hand" with which to test, in scheduled airline operation, the latest improvements in design. A few of the advantages were as follows:

1. Convair was able to check the flying ability of its airplanes under conditions analogous to those of commercial operation.

2. Flight-crew reactions to Convair airplanes were directly reflected in design improvements.

3. Passenger reactions and their suggestions were used to improve comfort design.

4. Service information on engines, propellers, and other equipment not manufactured by Convair, were obtained from Consairway as a guide to future purchases and requirements.

5. Data on cruising speeds, ranges, and fuel reserves, required for varied flight routes, were supplied to Convair designers by Consairway.

6. Consairway also supplied Convair with information on conditions which might be expected in different sections of the world—conditions requiring specialized equipment to overcome service difficulties.

7. Flight charts, and additional operating data furnished flight crews, were improved as a result of suggestions from Consairway operating personnel.

8. Consairway supplied service information which helped Convair reduce the time required for major overhaul on new designs. For example, summary reports were sent to the factory after every 100-hr., 500-hr., 1,000-hr., and 2,000-hr. maintenance and service checks.

9. Factors influencing the cost of airline operation were clearly brought to the attention of the designer.

The manufacturing research department at Convair continually tested factory design improvements by use of Consairway as a "proving ground". For example, Consairway tried out a new kind of sparkplug lubricant to keep plugs from seizing. Also, a new type of Lord shock-mount, for engine cowling and cowl flaps, was tested for less vibration.

These and many other advantages have shown that the close interdepartmental association between the factory and Consairway was of tremendous benefit to Convair.

Factors Which Boost Demand

Before discussing in detail the postwar design trends for commercial aircraft at Convair, let us consider the fundamental factors predicating them.

These trends at Convair are based primarily on factors which increase the demand for air transportation. Six of these factors which obviously increase such demand are: 1. High speed, 2. maximum safety, 3. minimum charge to the customer, 4. maximum comfort, 5. high frequency of schedules offered, and 6. assurance that schedules will be completed on time.

We have listed speed first because it is, without a doubt, the prime justification for travel by air; and it readily may be agreed that it is possible for older forms of travel to match all of these factors except speed. But even though speed is of prime importance, it should be remembered that the demand for higher speed reaches the point of diminishing return when the necessary charge to the customer increases with decrease in the power-loading required.

Let us illustrate this point with an example: A potential airline passenger might be willing to pay $150 to fly nonstop from Los Angeles to New York in 10 hr., while he might only pay $120 to travel the same distance by train taking three days and three nights. In this case he might feel that the saving of more than two days is well worth the extra $30. But, if he is asked to pay a still higher fare to make the flight in 8 hr., he may feel that the saving of two additional hours is not worth much additional charge.

Second, the demand for postwar air transport is obviously a function of safety. Within the past few years, safety in air travel has improved tremendously. This is evidenced by the fact that airline insurance rates have steadily decreased. But, much can be done to overcome the traditional and inherent fear of flying which many people still possess. This fear seems most prevalent in persons old enough to remember the early stages of aviation development, when pilots and their passengers were considered daredevils. Maybe they were. But today one seldom hears a youngster say, "You'll never get me off the ground". This is usually the remark of an older person.

An airline crash is still considered prime news by the public, and newspapers have capitalized on this fact. But if the same number of people had been killed in an automobile or bus accident, the news usually excites only local interest. Thus, the increase in demand for postwar air travel is not only a function of improvement in safety; it is also a function of how well the public can be convinced of the fact that safety has been improved, and how well public fear can be overcome.

The charge to the customer is one of the most important factors affecting the demand. If the fare can be made low enough to compete with the postwar railroad and bus fares, the shift to a higher demand for air transportation will be automatic. But the fare is not directly controlled by the manufacturer or the operator. Cargo and passenger rates must first be approved by the CAB. However, the charge can be indirectly controlled because, as the operator becomes more proficient and thus

increases his investment rate of return, he naturally applies for approval to decrease the charges to the customer.

He does this for two reasons: First, he must survive competition; second, he must increase the demand for his service. The operator naturally looks to the manufacturer for new equipment with which to increase his investment rate of return and, as pointed out, an increase in rate of return will allow the operator to reduce charges to the customer and thus increase the demand for air travel.

As for the demand for comfort, this also reaches the point of diminishing return as the cost of increased comfort rises. For example, cabin supercharging, heating, ventilation, and soundproofing, also services for passengers, extra space per passenger, etc., are all items which increase passenger comfort. But they also increase operational costs by decreasing the allowable payload. Thus, a compromise must be made between the demand for increased comfort and the demand for decreased operational cost. Since the inherent cost of comfort may be traced to the weight of the payload it displaces, the manufacturer is constantly striving to decrease this cost by weight-saving comfort design.

The remaining two items which we have listed, namely frequency of schedules offered and assurance they will be completed on time, are primarily controlled by the operator. Utilization of operating equipment, improved avigational aids, and dependability of weather forecasts, are but a few of the important factors tending to improve frequency and assurance of schedules. Because these items are not actually controlled by the manufacturer, we shall not discuss them further.

Influences On New Design

Now for the trends themselves: In keeping with the policy of increasing the demand for postwar air transportation, design trends for commercial aircraft at Convair primarily are based on: 1. Operational safety, 2. high speed, 3. comfort, and 4. maximum investment rate of return to the airline operator.

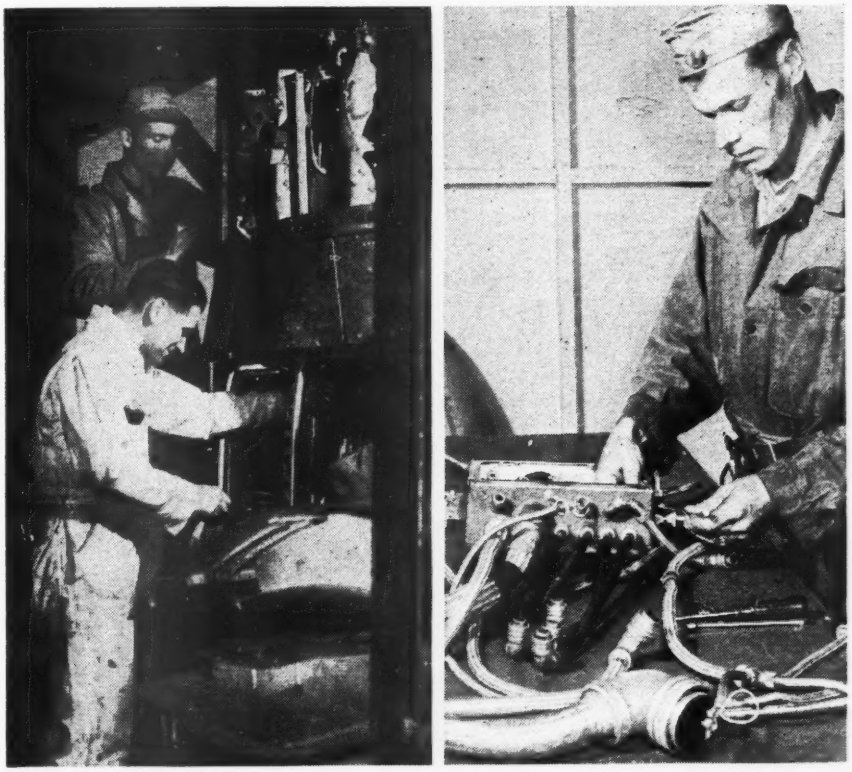
Design specifications chosen to give maximum comfort are, on the whole, independent of those chosen to give high speed, operational safety, and maximum investment rate of return. The airline operator usually dictates comfort requirements in accordance with the public demand for comfort on the particular route to be flown. For example, this comfort demand in long-range high-altitude operation is much greater than that for feederline low-altitude operation. The reasons are obvious. Convair's postwar policy is to decrease the operational cost of comfort and to furnish as much of it as the airline operator deems necessary for his particular type of operation.

The problem of choosing design factors which represent the optimum relation between speed, safety, and investment rate of return is not an easy one. CAA regulations dictate minimum safety requirements, and they also limit landing speed, the latter in effect limiting the maximum wing-loading for a given gross weight and a maximum lift coefficient. Thus, beyond this point, high speed cannot be obtained by increase in wing-loading; it can only be obtained by improvement in aerodynamic efficiency or by decrease in the power-loading. Aerodynamic efficiency is constantly improving and, within limits, power-loading may be decreased at will. But, as previously indicated, the demand for high speed resulting from a decrease in power-loading soon reaches the point of diminishing return.

CAA regulations also dictate minimum climb requirements. This in effect determines the maximum power-loading allowed for a given takeoff gross weight. Any lower power-loading may only be justified if the public demand for speed will support higher rates, or if it can be shown that an increase in the investment rate of return to the operator will result. Thus, it can easily be seen that the effect of CAA regulations on postwar design is far-reaching. For this reason it has been held important that CAB establish postwar regulations before postwar airplanes have been designed and built.

Almost everyone will agree that the war has accelerated aircraft improvements; it has developed safer operating techniques, and it has given us more data and experience upon which to base an improved set of CAA regulations. The sooner these regulations are definitely established the easier it will be for the designer.

Just as military designs at Convair were based primarily on specifications for maximum performance, so present-day commercial designs are based on specifications which accent maximum investment rate of return to the airline operator. Let us explain what we mean by investment rate of return: When monthly direct flying costs and fixed charges are deducted from direct flying revenue, the remainder represents investment return; when the return is divided by the total airline capital, the dividend represents the investment *rate* of return. These thoughts may best be expressed in equation form, as presented herewith (center column, next page).



Line saved considerable time and expense by development of engine buildup kits employed in special three-phase operation. Left photo shows step in mating of engine and mount, phase including final accessory connections, attachment of cowling subassembly, and preparation of firewall connections for final installation. Another step in this phase is seen at right, where mechanic works on junction box subassembly.

Postwar commercial designs at Convair have been established to make "*j*", the investment rate of return, a maximum by proper choice of fundamental design factors.

The factor Y represents the revenue rate, in dollars/ton-mile, charged the public; and as pointed out, it is only indirectly controlled by the manufacturer and operator. This factor naturally varies with amount shipped and distance shipped, and it may vary with speed if CAB decides to allow higher rates for the higher speed traffic. In any case, it is not a fundamental design factor and is not directly controlled by the manufacturer. However, it is essential that the manufacturer be kept informed as to the expected postwar rates because, as will be shown, these rates definitely affect the choice of design factors which give a maximum investment rate of return to the airline operator. Thus, it is very important to the designer that CAB approve postwar rates quickly.

Also, the fixed charge F, which includes hangar rent, advertising costs, fixed salaries, etc., is not essentially within the aircraft designer's control. It is true that the fixed charge is not entirely independent of the choice of fundamental design factors, such as wing-loading, power-loading, etc.; but for the most part, any dependence is secondary when compared with the effect which these factors have upon direct flying costs, block speed, and payload. For this reason, the fixed charge will not be discussed in detail.

Since factors such as X, V_b, L, and U are very definitely a function of the designer's ability, it seems reasonable that commercial designs should be controlled in such a way as to make $Z = (Y-X)V_bLU$ equal to a maximum. By making Z (which may be called the manufacturer's design factor) equal to a maximum, the investment rate of return to the airline operator will then be at a maximum.

It is admitted that the utilization U is not an easy factor to evaluate, especially for a new airplane which has had no service and maintenance experience, but it is, nevertheless, as important a design factor as is block speed, payload, or direct flying cost. Engine serviceability, quick change units, accessibility for repair and maintenance, etc., are but a few of the important design items when striving to increase utilization. Of course, the actual utilization in service is dependent upon the operator's ability, also upon the limitations of the particular air route. However, it is the manufacturer's job to see that utilization *potential* is made as high as possible.

Design specifications established to make the utilization potential a maximum do not necessarily interfere with those established to make Z' a maximum, where $Z' = (Y - X)\,V_bL$ and $(Z = Z'U)$.

Obviously the choice of fundamental design factors, such as power-loading, wing-loading, fuselage size, etc., directly affects the items in the formula for Z', and in addition, the optimum choice of these factors depends on the intended range and altitude of operation. Easiest way to show the process

$$j = \frac{N(Y - X)V_bLU - F}{I} = \text{investment rate of return per month}$$

where N = number of airplanes operated by the airline
Y = revenue charge to public, dollars/ton-mile
X = total direct flying costs, dollars/ton-mile (as obtained from an Air Transport Assn. cost analysis*).

$$V_b = \frac{D}{T_c + T_t + \frac{D - D_c}{V_g}} = \text{Block speed, mi./hr.}$$

L = payload, tons
U = Utilization per airplane per month, hours/airplane/month
F = Fixed charge, dollars/month
I = Total airplane capital investment, dollars
D = Trip length, mi.
T_c = Time to climb, hr.
T_t = Time to maneuver, hr.
D_c = Distance traveled in climb, mi.
V_g = Cruising ground speed, mi./hr.

* Total direct flying costs, as computed by standard ATA method, include flight-crew pay and expense, fuel and oil, airplane depreciation, engine depreciation, engine overhaul and repair, airplane overhaul and repair, airplane and engine ground service, and airplane insurance.

by which the designer finally arrives at the optimum combination for a given set of design specifications is to discuss the effect that each design factor has upon X, V_b, L, and Z' when the other design factors remain fixed.

As an example, consider the effect of decrease in fuselage size by decrease in fuselage cross-section. This causes some decrease in drag and an increase in the block speed V_b. It also causes a decrease in operating weight empty, a decrease in the fuel required for a given range of operation, and consequently an increase in payload L for a fixed takeoff gross weight. Thus, since

$$X = \frac{\Sigma\$/\text{hr}}{V_bL}$$

and since both V_b and L increase with decrease in fuselage size, the net effect on Z' will be to increase with decrease in fuselage size.

For a cargo airplane the obvious limit to this process is reached when the fuselage cargo density reaches some value equal to the average density expected for the particular operation, i.e., when the ratio

$$\frac{\text{Payload}}{\text{Usable Fuselage Vol.}}$$

reaches a value such as 10#/ft.[3] In this case, since both V_b and L increase with decrease in X, it is obvious that Z' will be highest when X is lowest. But this is not always the case:

When power-loading is used as the independent variable, an entirely different picture is obtained. Let it be assumed that the power plant size is to be increased over and above that necessary to meet minimum CAA climb requirements for the maximum takeoff gross weight. An increase in power plant size (decrease in power-loading) causes an increase in block speed, V_b, and an increase in \$/hr. operating cost, but it also causes a decrease in payload L for a given takeoff gross weight. Thus V_b goes up and L goes down, and the net effect upon X, which is a function of

$$\frac{\$/\text{hr}}{V_bL}$$

is not obviously predictable.

Even if the net effect were to slightly increase the direct flying cost X, it might still be advisable to go to the lower power-loading, for these three reasons:

1. Even though analysis shows that X increases, investment rate of return might go up due to net effect of increase in V_b upon Z'.

2. Revenue charge Y, if established by CAB to be a function of speed, may not have yet reached the point of diminishing return, in which case public demand for resulting higher speed may support an increase in revenue charge to the customer on the basis of speed increase alone. In this case also, net effect may be to increase investment rate of return even though X increases.

3. Even though net investment rate of return, as computed from the formula for "*j*", remains unchanged, the operating payload factor will be higher on the higher speed airplane because people would rather ride on the faster airplane.

To explain the first reason more fully: Airplane (A) may show a higher total direct-flying cost than does airplane (B). Thus, every time (A) carries one ton one mile it makes less profit than (B). But, if (A) delivers enough more ton-miles per month than (B), it will show a higher investment rate of return to the operator. This is especially true if the utilization factor is high. A simple example in arithmetic shows this very clearly, as follows:

Airplane (A) may operate at a cost of 14¢ per ton-mile while airplane (B) operates at only 12¢ per ton-mile. If the revenue rate is 30¢ per ton-mile, this will mean that (B) will make 18¢ each time it carries one ton one mile while (A), will only make 16¢. But, if due to higher utilization, higher payload factor, or higher speed, (A) can deliver 7 ton-miles in the same *time* that (B) delivers 6, obviously

(*Turn to page* 253)

AIRLINE EARNINGS PEAK SIX MONTHS OFF?

By RAYMOND L. HOADLEY, *Financial Editor, "Aviation"*

Almost baffling has been the continued climb of transport revenues and stock prices—a climb that our analyst says may hit a ceiling as load factors decrease and financing for additional new equipment becomes necessary.

TODAY'S UPWARD TREND in airline earnings probably will continue until next summer. By that time the payloads of the air transport companies may begin to decline rather sharply. And, as Wall Street observers figure it out, then will come the first real postwar test of whether or not the industry can increase, or even maintain, its wartime earning power.

Earlier this year many industry officials felt that reductions in passenger fares, excess profits taxes, and mail rate reductions would cut 1945 profits under the record 1944 levels. But steady gains in traffic volume, as more planes became available, easily surmounted these obstacles, and increased profits for the industry again seem assured this year.

Prices of airline stocks have risen to such heights that Wall Street brokers have closely followed the industry's earnings trend for the past year, apprehensive that any interruption to the upward profits curve might bring considerable selling into the airline stocks.

That's why some Wall Streeters were a bit uneasy when the Civil Aeronautics Board cut the airmail rate of the "Big Four" from 60¢ to 45¢ a ton-mile, retroactive to Jan. 1, 1945. Just previously, air fares were reduced around 5¢ a mile by the airlines.

Yet the steady release of transports for the commercial runs has more than offset these adverse factors. Today the domestic lines have over 400 transport planes in operation; double the number flying two years ago. And with this vastly increased seat capacity the average payload continues at better than 90 percent.

However, the estimate is commonly heard in trade circles that the ratio of passengers to the number of seats will be sliding off by the summer of 1946 and may decline to 65 percent by 1947 when the domestic and international lines together may have more than 1,000 transports in use.

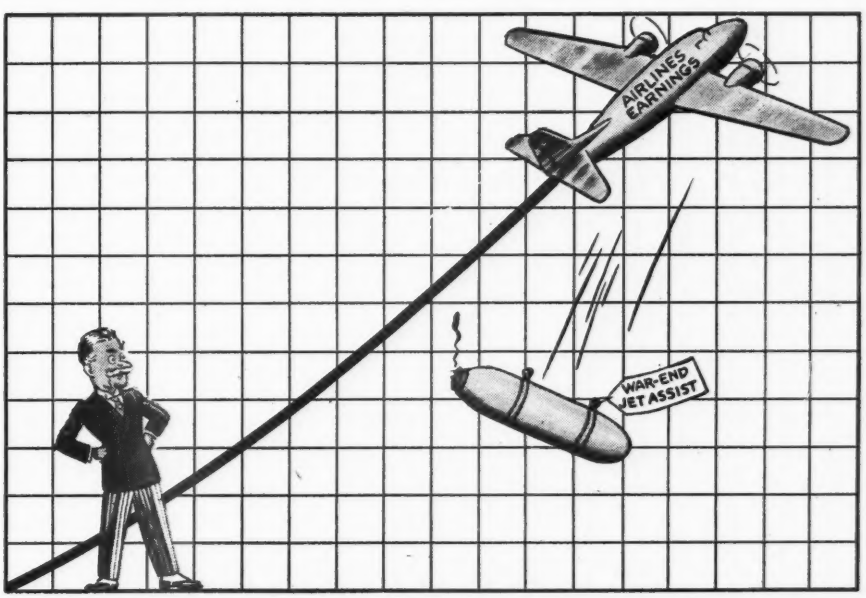
During the war the airlines haven't had to pay too much attention to operating expense and overhead. But with plenty of seats available once more, the time will come within the next 18 mo. when regular peacetime conditions will prevail. Also by 1947 the common stocks of many of the airlines are going to be somewhat diluted as compared with 1939 capitalizations. At that time the industry will be right in the midst of financing new equipment through loans, bonds, and additional stock.

In the meantime nearly all surface indications are bullish on the airlines. First and foremost among these is the excess profits tax situation. When the war broke out and heavy corporate taxation became the order of the day, it looked as if this fast growing industry would be hard hit. Its prewar earnings had not been large enough to establish an adequate tax base. So it first appeared that the industry not only would lose part of its flying equipment to the armed forces but would also have a large part of its earnings siphoned off by the excess profits tax.

But Congress seemed to realize that the industry had an unusually low earnings base and was acutely in need of building up its working capital. Also that the airlines were aiding the military forces through vast and far-flung transport operations on virtually a cost basis.

The result has been that most of the airlines have little kick coming with respect to wartime taxation. Congress

(*Turn to page* 251)



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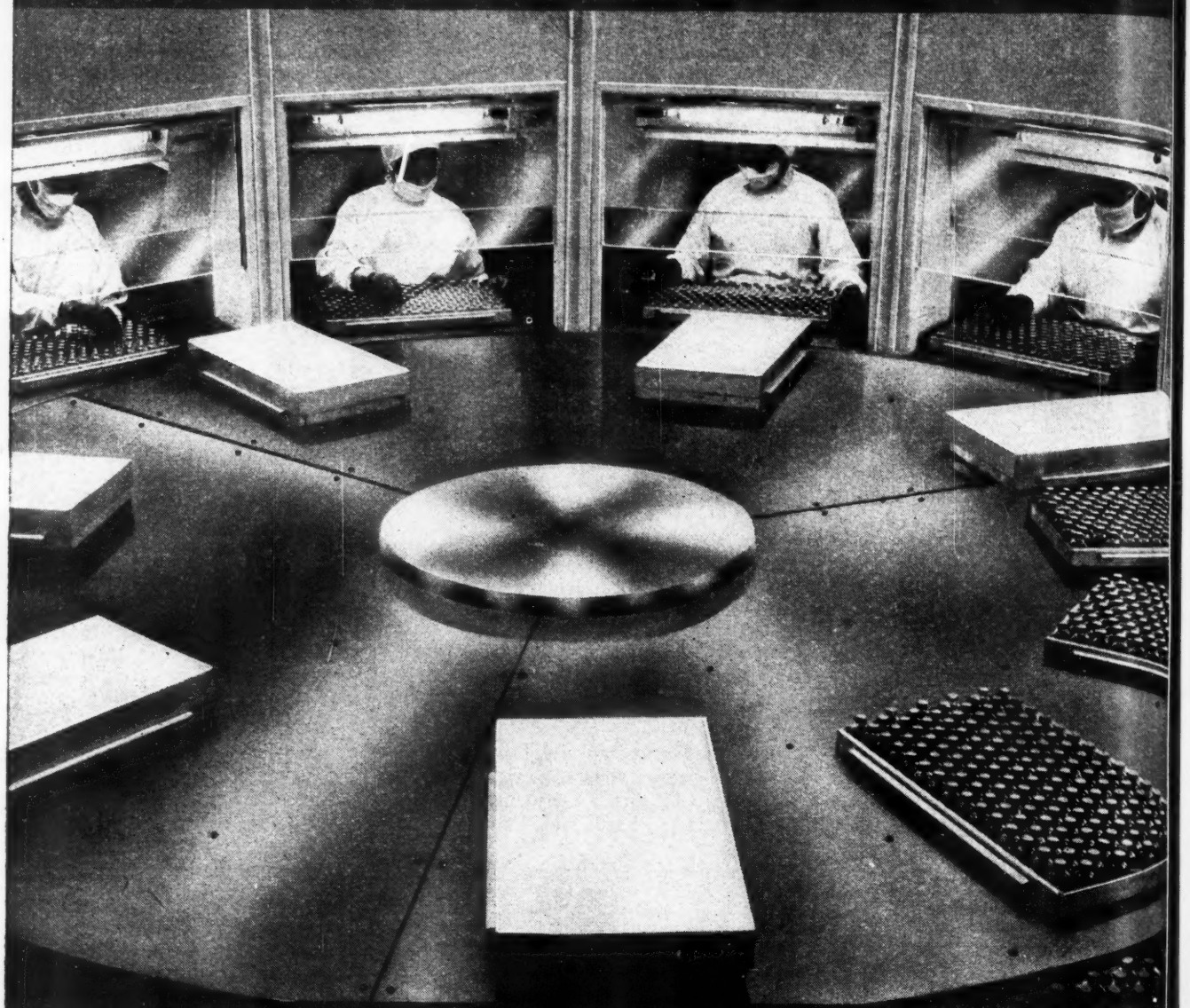

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Bellcrank Production Boosted By Switching Weld Location

HOW SMALL-DETAIL FABRICATION ECONOMIES can be effected is typified in this relocation of fillet welds. Changing from fillet applications at tight inside corners of Martin Mariner bellcrank assemblies to outside areas readily accessible to the arc welding rod (Fig. 1) resulted in elimination of production slow-down and afforded superior attachment strength of the parts.

In the original design of the bellcrank assembly, consisting of two flat arms welded ¼ in. apart on a cylindrical detail, the engineering drawing called for two fillets to be welded on the two inside corners in the ¼-in. space. It developed, however, that welding of the fillets was impossible because physical limitations of the process were overlooked in design of the bellcrank.

Size of rod used in arc welding ranges from $\frac{1}{16}$ to $\frac{3}{8}$ in. and the diameter used depends upon the thickness of the parts to be welded to maintain a proper proportion between the base and the filler metal. Thus, in welding the bellcranks, ⅛ dia. rod was employed. The arc length, measured from the tip of the rod to the surface of the molten metal, is usually equal to the dia. of the welding rod.

But because of the limited space, the arc could not be controlled, and this lack of control made it impossible to concentrate the arc in the two corners, as specified on the drawing. On most of the assemblies that were welded before the change, the arc was struck across the two arms. Consequently, no fillets could be formed, and the ¼-in. space became completely filled by the weld (*a*, Fig. 2). Although these assemblies appeared to be satisfactory after welding, some were rejected on inspection because of insufficient weld penetration of the cylindrical detail. And in some cases, the cylindrical detail could be broken loose and turned independently of the two arm units.

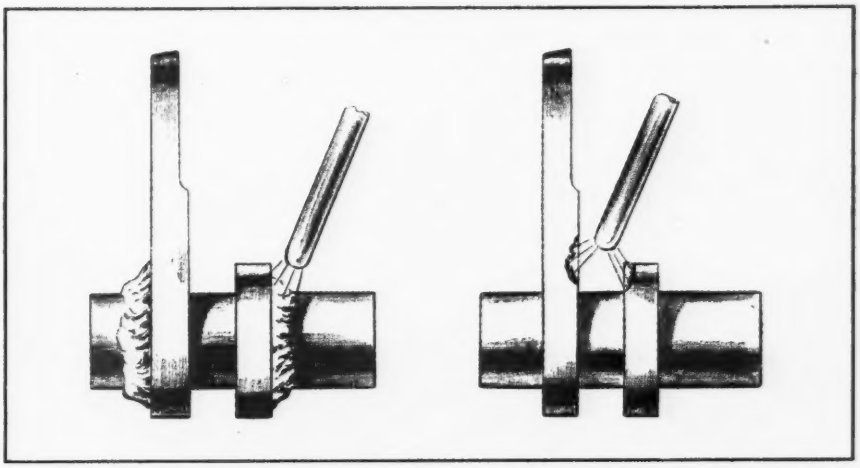

Fig. 1. Location of welded fillets at outside corners of bellcrank assembly (left) indicates how welding rod may be applied without interference, whereas with inside application (right), there is insufficient space for rod, hence proper weld is not possible.

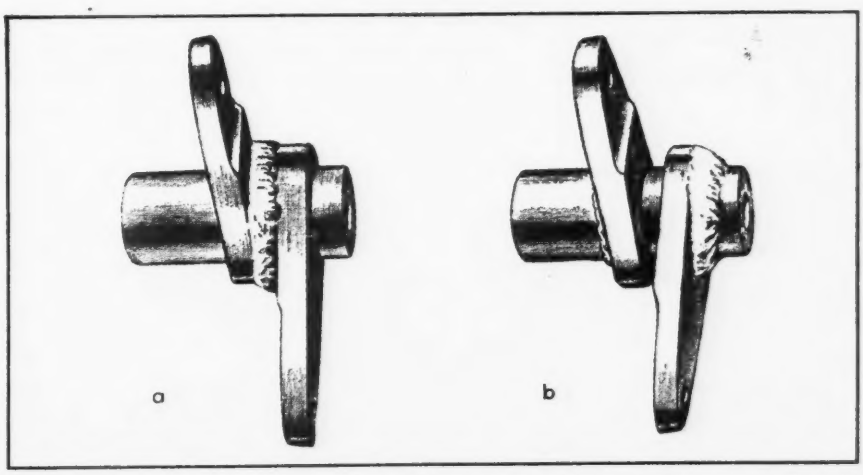

Fig. 2. Comparison of bellcrank assemblies before and after fillets were changed. Fillet weld specified for unit shown at (a) could not be performed because of space limitations, and although apparently strong, some parts were rejected because of insufficient weld penetration of cylindrical detail. Bellcrank seen at (b) was properly and easily welded after change.

As a solution, the fillets were made accessible by relocating them on the other sides of the arms (*b*, Fig. 2), and since the outside surface of the cylindrical detail does not fit to any mating part, fillets welded on the outside does not affect its function.

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Production Costs "Clipped" With Clips

USE OF THREE SIMPLE spring clips (Fig. 1) to stow the engine emergency crank on the Martin PBM Mariner, extensively cut manufacturing costs by eliminating a complex bracket arrangement (Fig. 2) consisting of numerous details.

The three clips are identical, are bent up from 1025 cold rolled .028 strip, and each is attached to the bulkhead with two rivets. Only other detail required is a small aluminum stiffening member, fastened on the other side of the bulkhead, to strengthen the loaded area. Installation time was held down by locating clips and stiffener so as to utilize existing rivet holes.

Crank support arrangement used on the earlier planes was designed to hold two cranks. However, one crank was found to be unnecessary and was eliminated in a subsequent stripping program to save weight. The only design change made on the bracket at that time was to bolt a block of wood to each assembly to fill the space left by the deleted crank.

The old design involved considerable expense because of the many different operations entailed and the large variety of materials used. The brackets consisted chiefly of bent-up sheet metal details assembled by riveting. Two aluminum stiffeners, much larger than that used in the redesign, were needed to strengthen the bulkhead. And required for these metal details were shearing, sawing, burring, hydro-

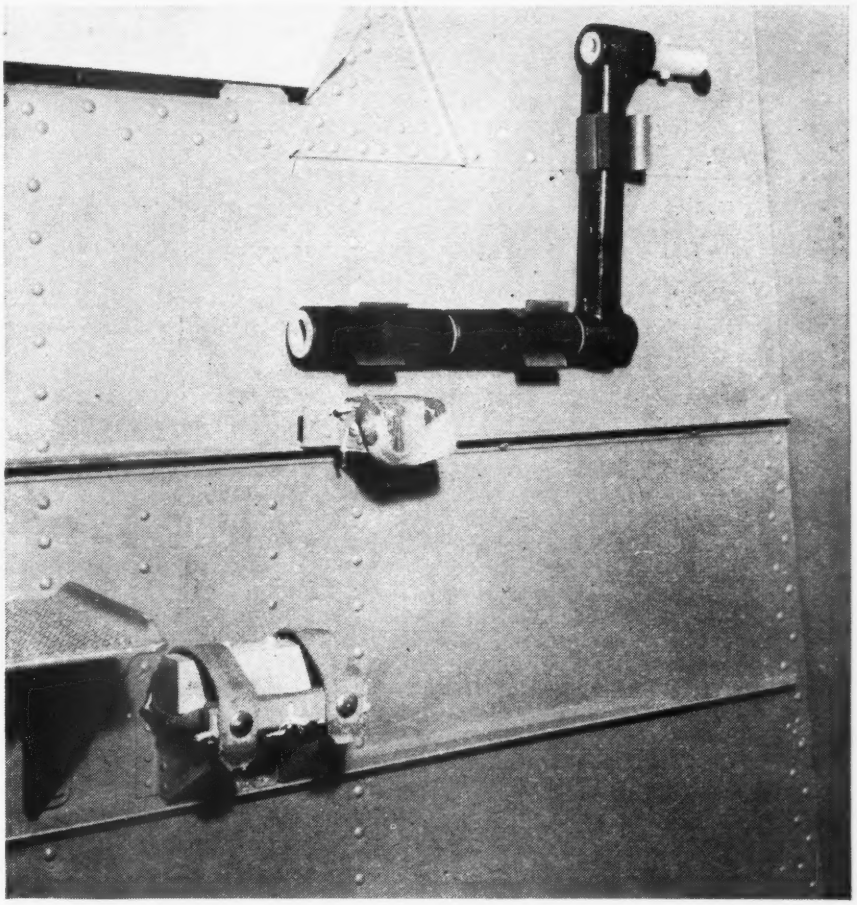


Fig. 1. Seen here are comparative installations of former engine crank supports consisting of many small details, and new simple steel clip arrangement for which existing rivet holes are utilized. Old design required undoing of three snap fasteners, whereas neater clip installation permits easy removal and replacement of crank.

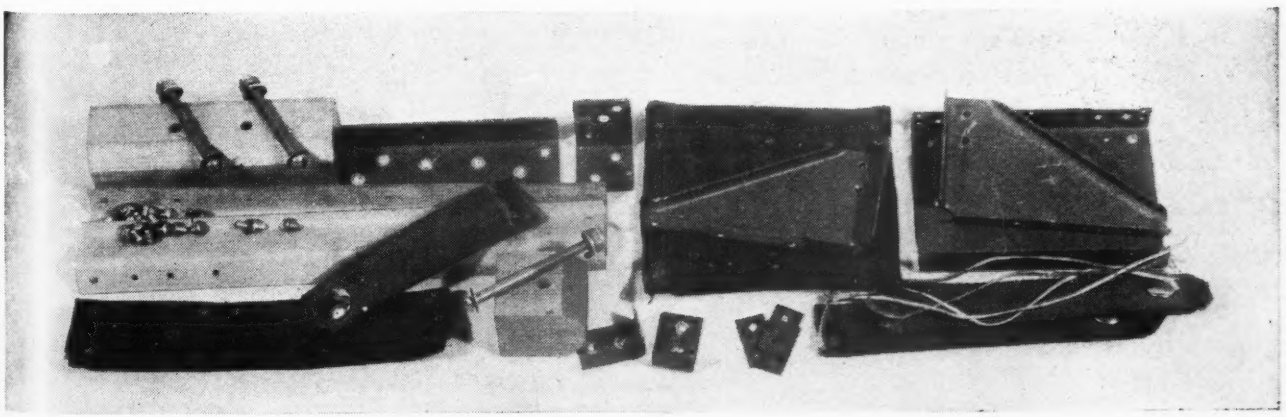
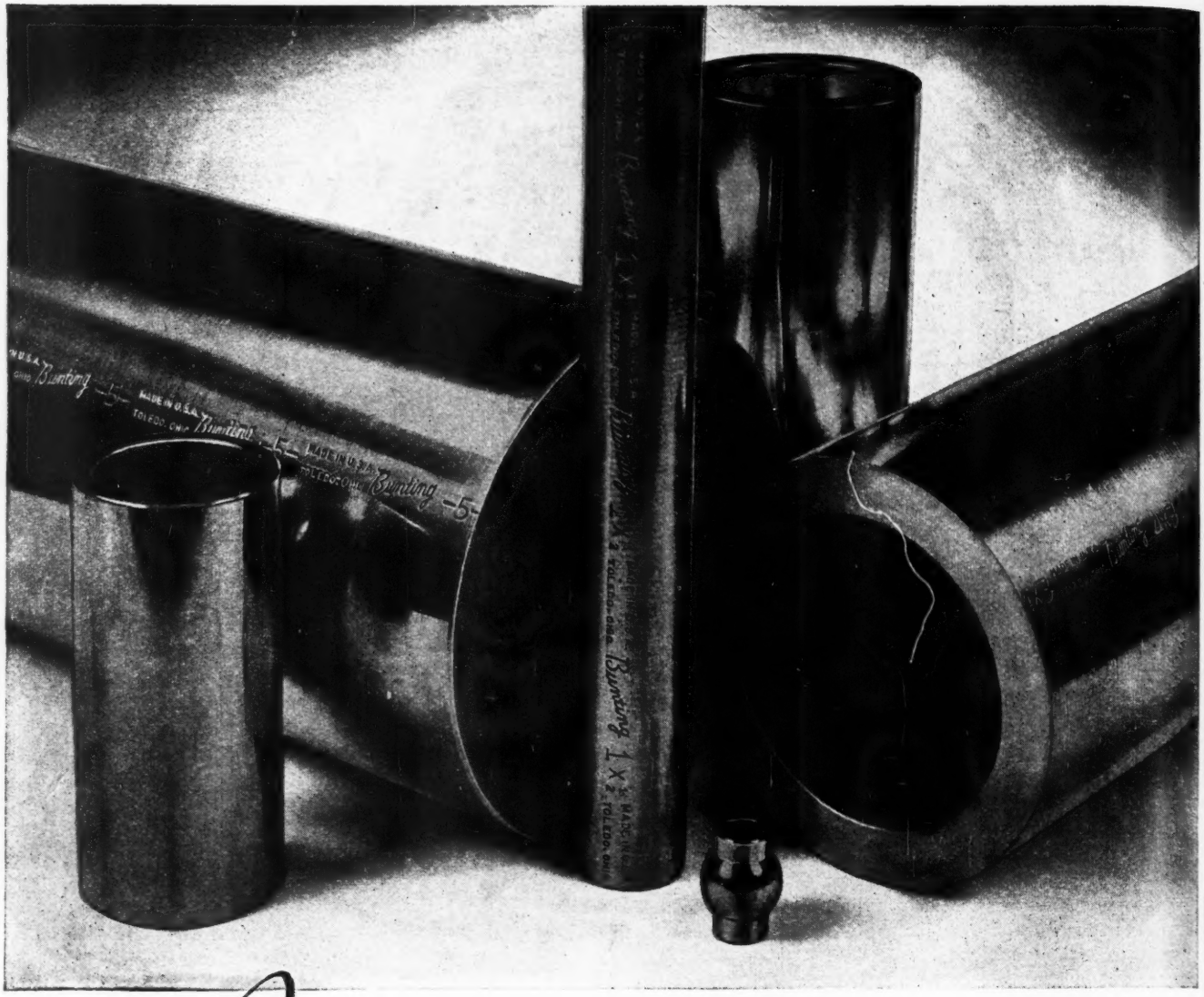


Fig. 2. Components of crank supports before redesign. Note amount of forming, drilling, riveting, and sewing necessary for assembly and installation.



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press, forming, brake bending, drilling, anodizing, priming, and finish painting.

The crank was originally cushioned by canvas padding laced to the metal brackets. Preparation of this padding alone, before assembly, required numerous operations such as laying out, cutting, folding, sewing, inspecting, waterproofing, drying, part number stamping, and piercing of lacing holes.

Another costly detail was the fabric strap (three were used) which previously held the crank in place by snap fastener. To make this detail, rolls of the fabric were marked and cut to length, after which the corners were cut off diagonally and waxed. Next, holes for the snap fasteners were punched on an air machine, and after the fasteners were assembled, the straps were stamped with the part number, inspected, and then sent to a stockroom.

It was also necessary to mask the straps with tape to protect them while the assemblies were sprayed with primer, previous to installation. After installation in the plane, the masking operation was repeated on the assemblies for the final finish coat.

Addition of the wood spacers in the early change added woodworking and finishing operations. These included sawing the material to length and width, shaping, drilling two bolt holes, and spraying. After the usual part number stamping, the spacers were inspected and sent to stock.

Another consideration was interdepartmental transportation—an important cost item in the manufacture of assemblies having numerous and varied details. Cost studies showed that 71 individual trips to various parts of the factory were required in the assembly and installation of the old design upper unit alone, and whereas no similar study was made on the lower bracket, it was obvious that at least the same number of trips were involved.

In addition to the cost-saving factor, other advantages of the redesign were:

1. Weight saving. The three clips and the single stiffener weigh only 5 oz., whereas the original brackets, with the two stiffeners, weighed 13½ oz. Though small, the difference—about 9 oz.—represents an important saving in an overall weight-saving program.

2. Accessibility. The crank can now be quickly removed from the clips and speedily replaced without the necessity of unbuttoning or re-fastening any straps.

3. Reduction in paper work. Numerous routine procedures by various departments not engaged in actual assembly and installation of the brackets were eliminated. These included blueprinting, material purchasing, business machine parts listing, tool write-ups, stock records, requisitions, and other incidental procedures.

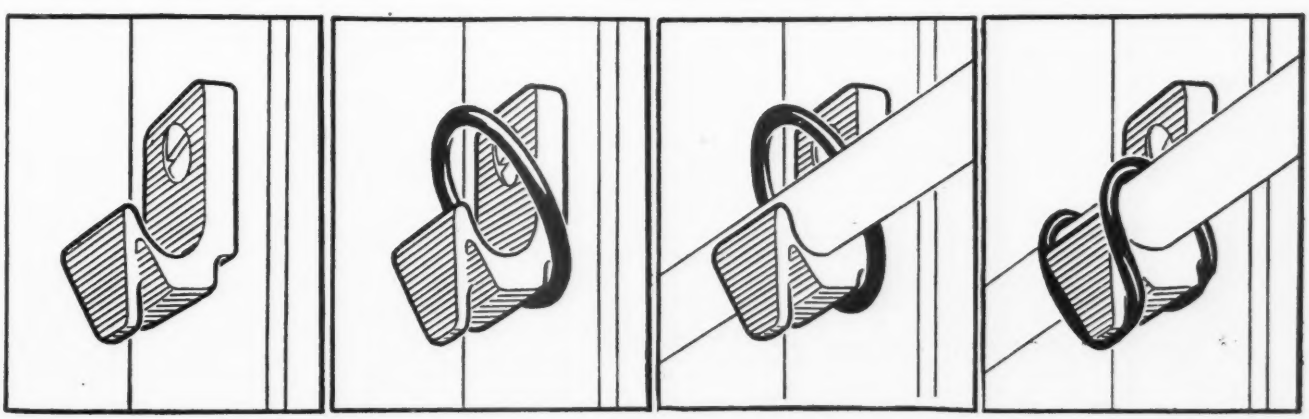
And only two A-size engineering drawings were required in the new design—one for the clip and one for the stiffener. The original design required two assembly drawings and 14 A-size drawings for the details.

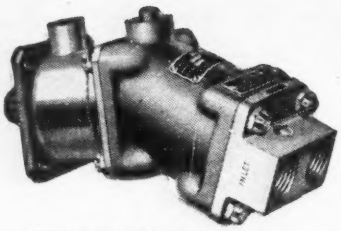
The original crank support provides a good idea of the expense involved in manufacture of a part made up of numerous details fabricated in scattered parts of the shop. Deletion of even one material or process, while the design is still on the drawing board, will substantially reduce the cost per part. Careful visualization of the manufacturing steps required to make a part, with an eye to elimination, rearrangement, or combination of materials or process, will often reduce manufacturing costs and release personnel and facilities for other work.

Tube Clamp Features Jiffy Action

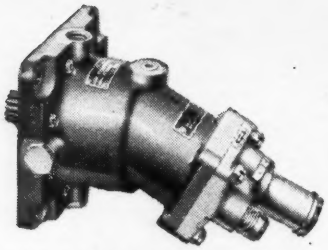
EASE OF MAINTENANCE and simplicity of design are notable in this new quick-lock tube clamp device developed at The Glenn L. Martin Co. As seen, the clamp is shaped like an inverted "S" and is fastened to the frame with a single screw. Tubing to be supported is placed in the open side of the curve, and a flexible clamping ring passes around the back of the base, over the top of the tubing down the front, then hooks under the curve at the front of the "S" to form a simple locking device affording rapid installation and removal.

The clamping ring—also serving as a shock absorber—can be made of rubber or other elastic material, and also suitable for use is a standard hydraulic seal "O" ring which has been rejected because of improper tolerance. Clamp proper can be molded from a fabric base phenol fiber material or fabricated from formed sheet metal.

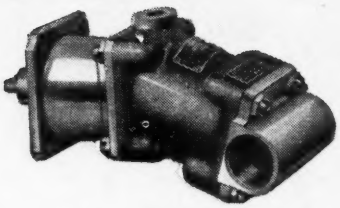




1000 PSI CONSTANT DELIVERY
PISTON TYPE PUMP



3000 PSI CONSTANT DELIVERY
PISTON TYPE PUMP

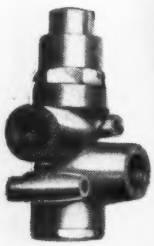


CONSTANT DISPLACEMENT
PISTON TYPE
MOTOR

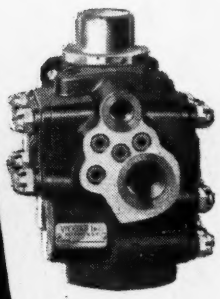
VICKERS

The Most Complete Line

OF AIRCRAFT HYDRAULIC EQUIPMENT

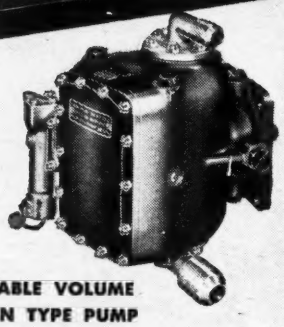


SEQUENCE VALVE
(MECHANICALLY
ACTUATED)

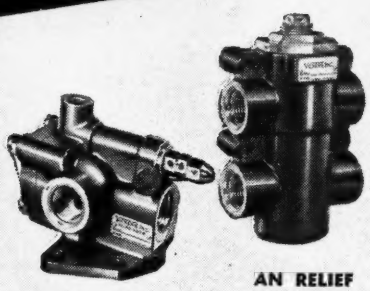


UNLOADING
VALVE

5", 7½" AND 10"
ACCUMULATORS

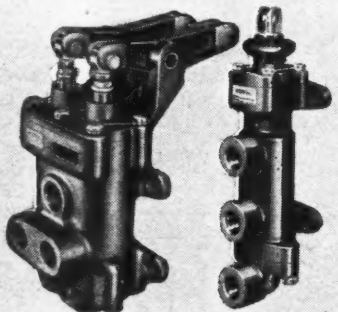


VARIABLE VOLUME
PISTON TYPE PUMP



RELIEF VALVE

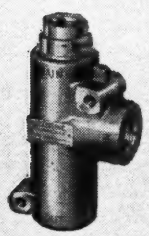
AN RELIEF
VALVE



DOUBLE
BRAKE VALVE

SINGLE
BRAKE VALVE

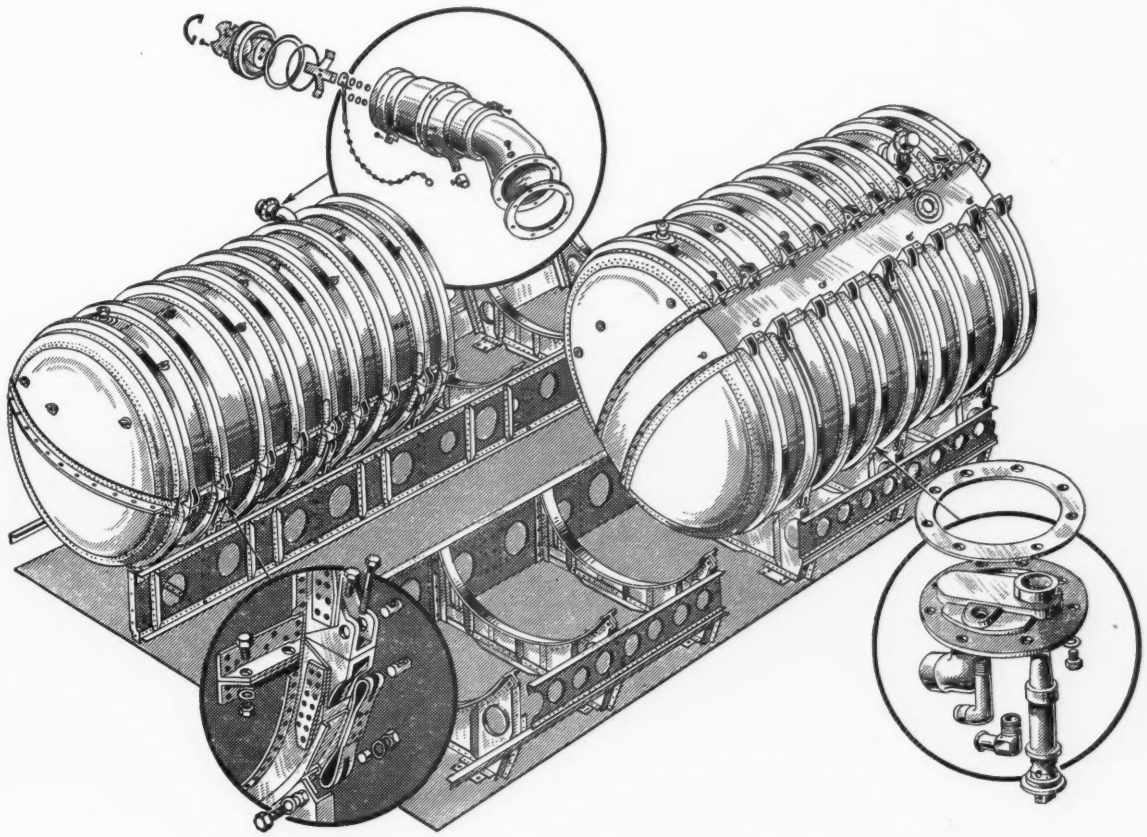
Having the most extensive line of hydraulic units, Vickers can meet the widest variety of aircraft hydraulic requirements and provide the important advantages of undivided responsibility. Vickers Hydraulic Controls are simple and dependable . . . smooth and accurate in operation . . . light in weight . . . easy to adjust . . . insensitive to shock and vibration. Vickers engineers will gladly discuss with you the application of these (and many other) units to your individual requirements.



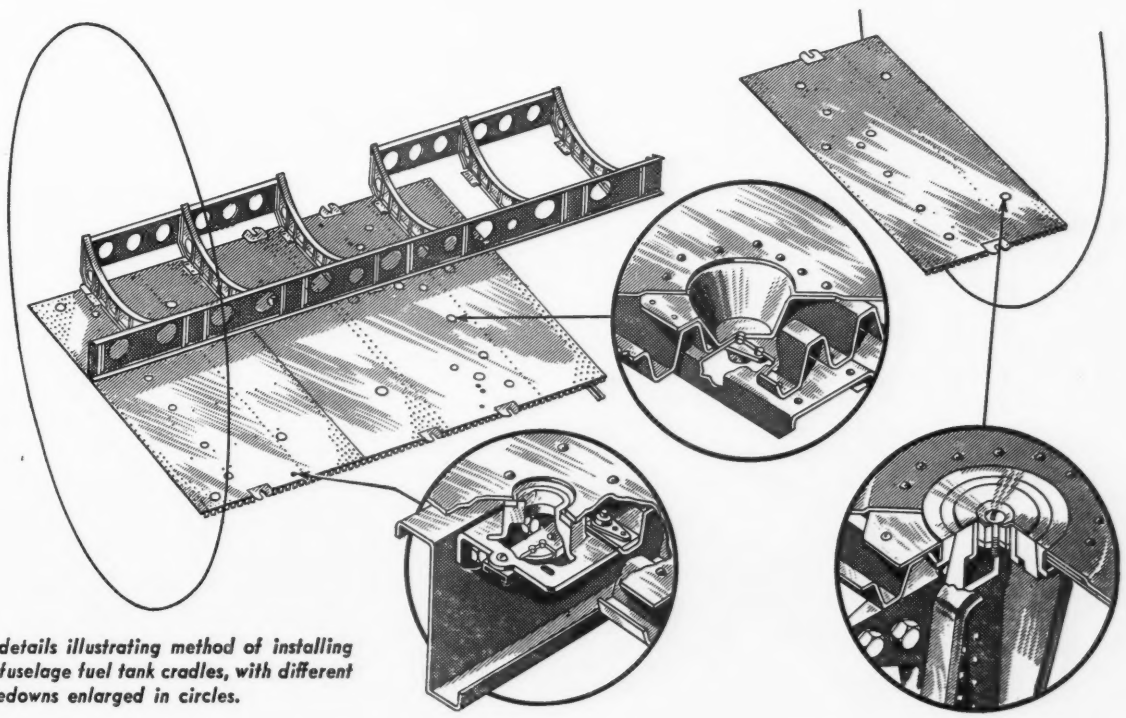
PRESSURE REDUCING
VALVE

VICKERS Incorporated

ENGINEERS AND BUILDERS
OF OIL HYDRAULIC EQUIPMENT
SINCE 1921



Douglas C-54 Skymaster long-range fuselage fuel tank installation, showing details of filler cap in circle at top; construction of fuel line attachment fitting in circle at lower right; and tank tie-down connection at lower left.



Shown here are details illustrating method of installing C-54 long-range fuselage fuel tank cradles, with different types of floor tiedowns enlarged in circles.

Sitting pretty . . .

and 7 pounds lighter

Made of Mazlo Magnesium, this new lightweight seat, designed by Douglas Aircraft Company engineers, reduces the weight per 21-passenger plane by 147 pounds. Yet it costs but slightly more than half the price of the old type chairs. This savings in weight alone, can mean an added passenger, or the revenue on 147 pounds of cargo.

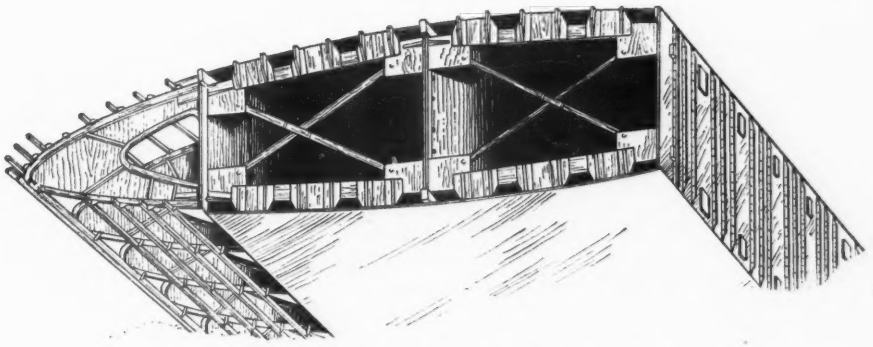
Here's something to think about when designing tomorrow's passenger, cargo and personal planes. Magnesium alloys give the required strength and dependability, along with maximum savings in weight.

American Magnesium engineers will gladly sit down with you and help you employ magnesium to best advantage. Write Aluminum Company of America, Sales Agent for American Magnesium Products, 1713 Gulf Building, Pittsburgh 19, Penna.

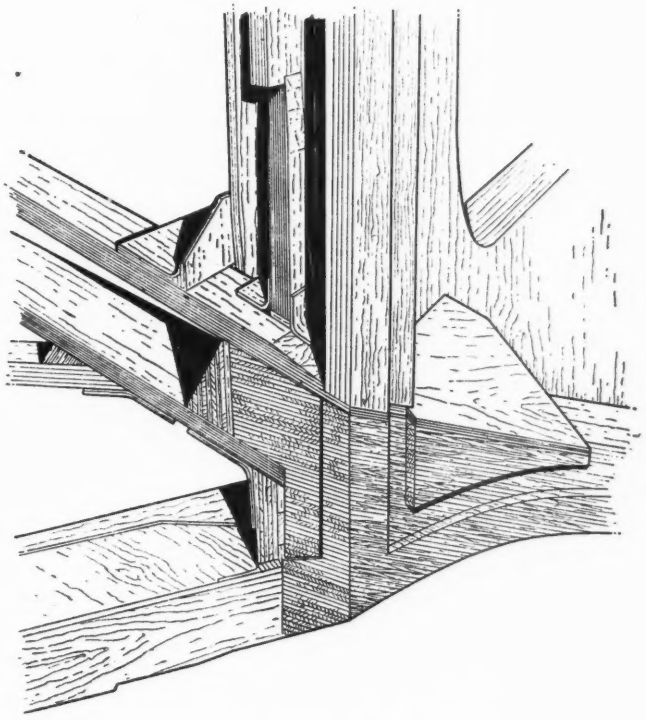
MAGNESIUM MAZLO PRODUCTS

AMERICAN MAGNESIUM CORPORATION

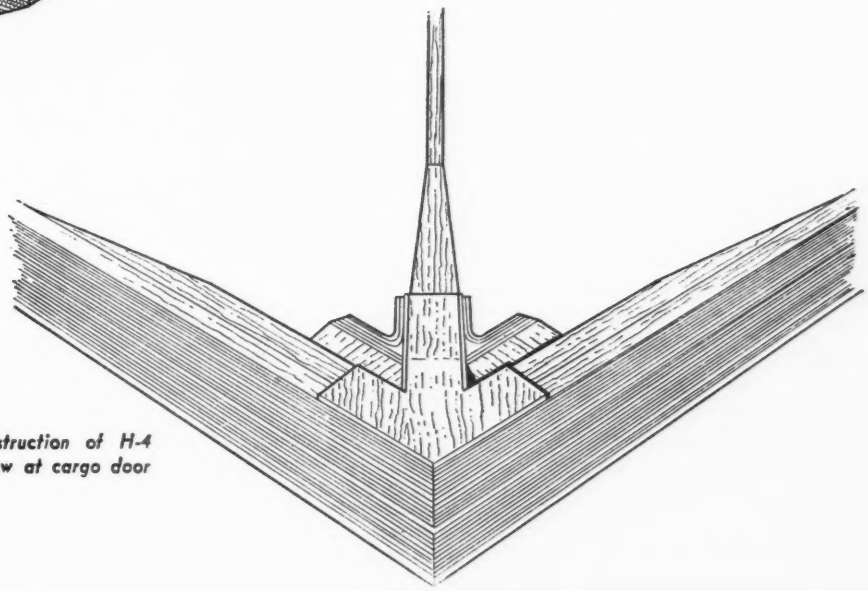
SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA



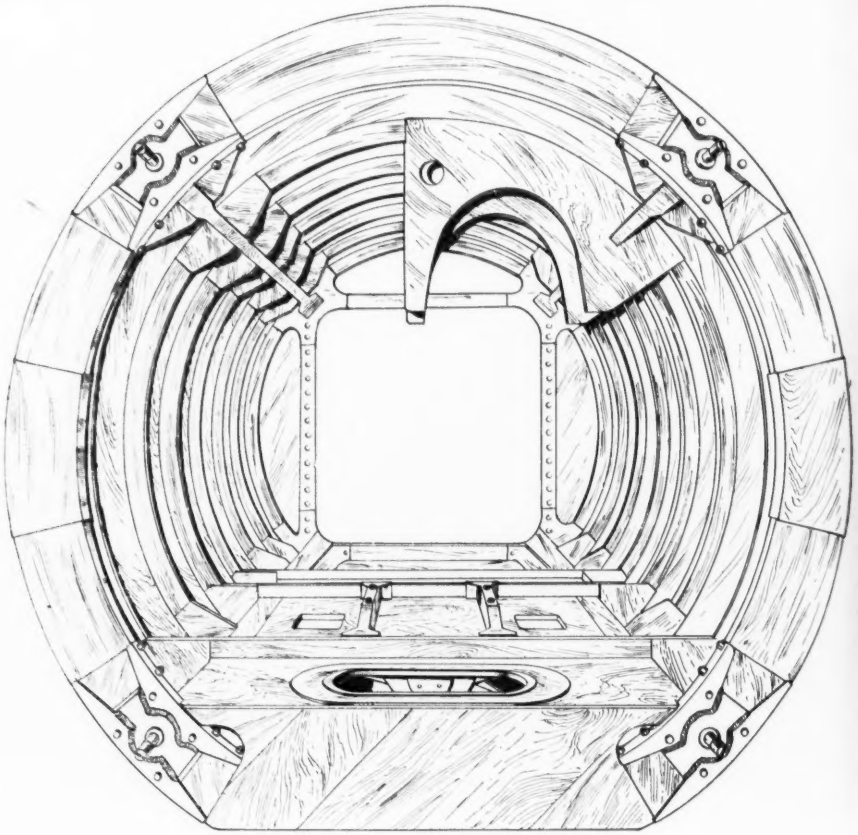
Profile of outer wing panel of leading edge of Hughes H-4 wing, with skin removed to show construction of leading edge. Trailing edge is built as separate structure and attached at rear spar.



H-4 flying boat cargo door jamb details, looking three-quarters aft at right side, showing end grains of laminates and use of wood flanges.

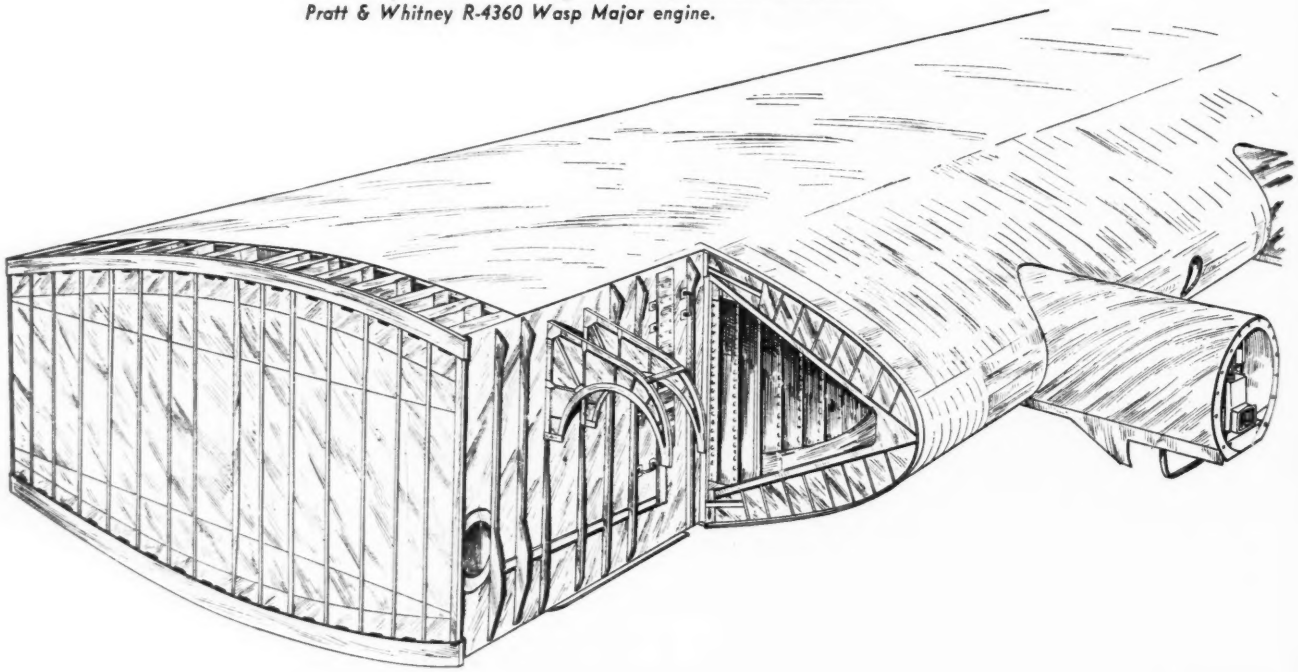


Detail sketch showing construction of H-4 all-wood flying boat hull bow at cargo door station.



Hughes H-4 engine nacelle showing, in foreground, metal fittings for attaching engine mount which supports Pratt & Whitney R-4360 Wasp Major engine. Cratt is fitted with eight such power plants.

Root of left wing of H-4 showing construction at that point. Note comparative size of engine nacelle, to which is attached Pratt & Whitney R-4360 Wasp Major engine.

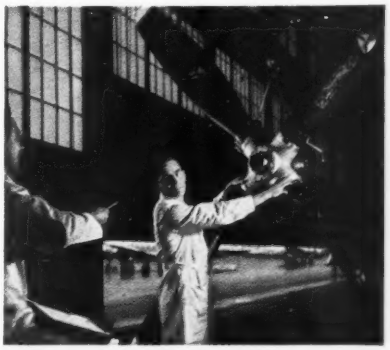


Battle Veteran with a Bright Future

This is a fighting Aeroprop, one of thousands used on Allied air armadas. With the war won, its battle performance now assures it an equally brilliant future.

The lightness, strength, and simplicity of this General Motors propeller adapt it to the exacting standards of commercial use. Its automatic, constant-speed operation, compact unit construction, and ribbed-steel hollow blades are among other Aeroprop features important to peacetime flight.

The Aeroprop continues to benefit by intensive research, engineering, and production development. That means continued improvement to meet changing needs. As it stands today, however, the war-proved Aeroprop represents basic achievements in propeller design and operation that will contribute greatly to flying's future.



Aeroprop Advantages—*Lightness* for payload . . . *Strength* for safety . . . *Simplicity* for easy service . . . *Faster Automatic Pitch Change* for flight efficiency . . . *Full Feathering* for engine protection . . . *Engineered* for reliability.

Aeroprop

LIGHT • STRONG • RELIABLE

AEROPRODUCTS DIVISION • GENERAL MOTORS CORPORATION • DAYTON, OHIO

Keep America Strong—Buy Another Bond!

* (1.) Torque it!

It has unequalled torsional strength

** (2.) Push or Pull it!

It has unmatched tensile and compression strengths

*** (3.) Run it under load!

It outlasts any conventional joint, withstands the most adverse operating conditions

Facts

demonstrate beyond question that Apex Heavy Duty Universal Joints are stronger, lighter, will outperform and outlast any joint you can buy.

The Reasons: Apex exclusive design balances the strength of the yokes, block, and pins to provide greater static and operating torque, highest shock load capacity, lowest deflection and maximum freedom from binding under overload. Apex exclusive cover (optional) seals lubricant in, seals foreign matter out, dampens vibration, minimizing fatigue and wear. More: it permits running Apex joints in corrosive or dust-laden atmosphere, in water, caustics, acids, etc. Apex joints won't throw oil, will not freeze at minus 75°F. nor fail at plus 250° F. Sizes: 3/8 to 1 1/2". Style of barrels: you name it. Write for Apex Joint "Data Rule."

Nominal size (inches)	* (1.) Static torque (inch-lbs.)	** (2.) Axial ten. & compres. (lbs.)	*** (3.) Recommended operating torque (inch-lbs.)
3/8	275	550	41
1/2	600	1000	90
5/8	1080	1500	162
3/4	2200	2000	330
7/8	3500	2500	525
1	5000	3000	750
1 1/4	10,000	4500	1500
1 1/2	14,500	6000	2175

APEX

Aircraft Universal Joints

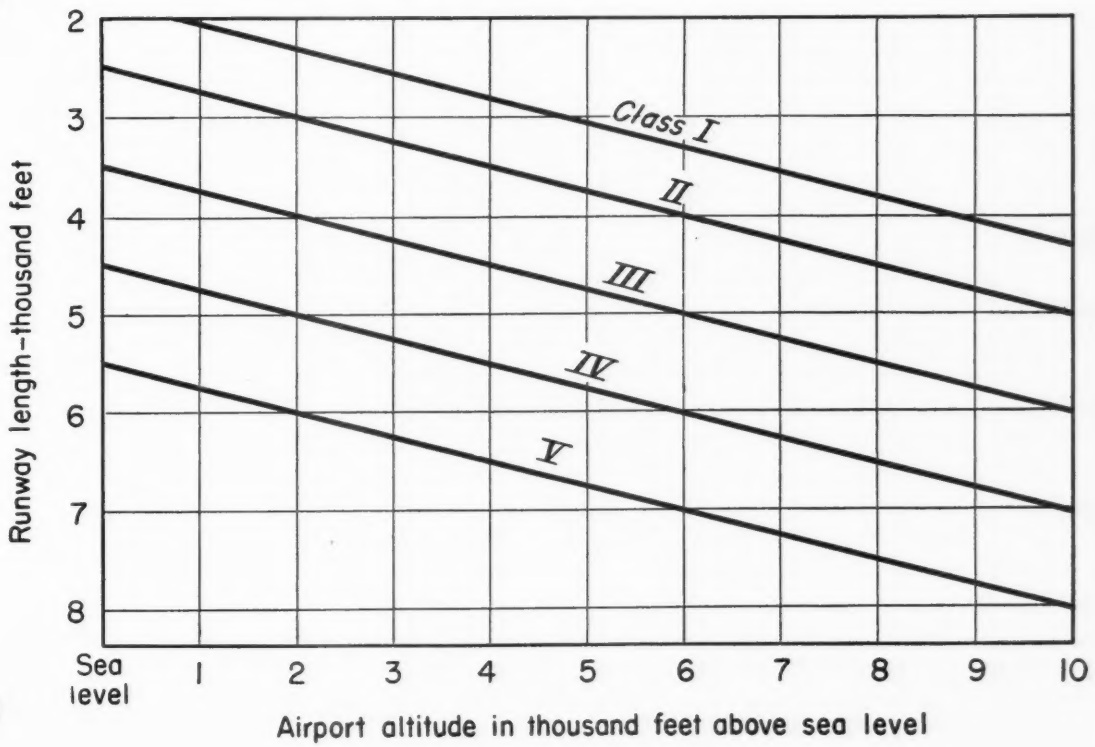
THE APEX MACHINE & TOOL COMPANY • DAYTON 2, OHIO

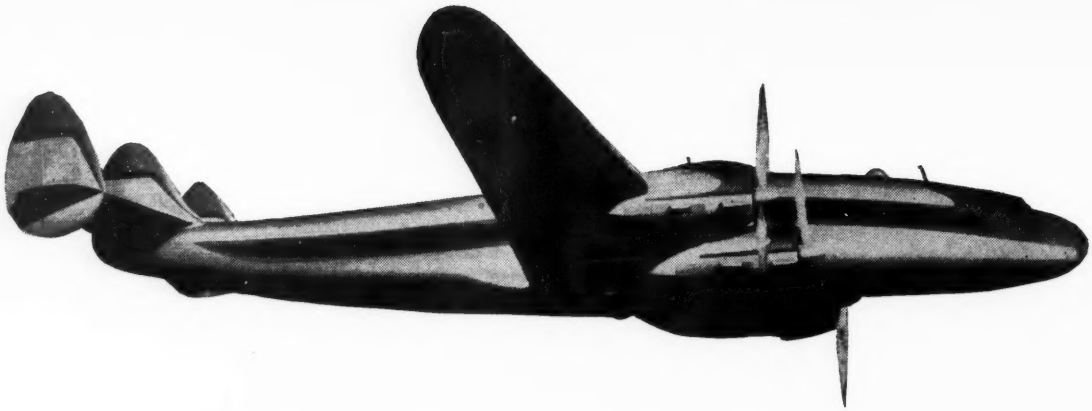
Exclusive Licensee Under F. & S. Joint Patents

SHEET NUMBER D-34
CLASSIFICATION . . . . . Construction
SUB CLASSIFICATION . . . . . Runway Length

DETERMINATION OF RUNWAY LENGTH FOR DIFFERENT ALTITUDES

It is known, of course, that lift is dependent upon pressure on wing surfaces and that accordingly any variation in air density will cause a corresponding change in the lift obtainable at a given ground speed. The greater runway length thus required as the altitude of takeoff is increased—roughly one-fourth of the altitude—may be quite accurately determined from the appended graph.





New World Standard

The claim is proved. Lockheed Constellations will bring new world standards in air transportation to every country on every continent. In regular scheduled service first on these great airlines:

AMERICAN AIRLINES OVERSEAS

EASTERN AIR LINES

FRENCH GOVERNMENT AIRLINES

ROYAL DUTCH AIR LINES (KLM)

NETHERLANDS INDIES AIRLINES (KNILM)

PAN AMERICAN WORLD AIRWAYS

PAN AMERICAN-GRACE AIRWAYS (PANAGRA)

TRANSCONTINENTAL & WESTERN AIR (TWA)

THE NEW AIRLINE STANDARD

Lockheed Constellation

Look to Lockheed for Leadership LOCKHEED *Years Ahead in the Science of Flight*

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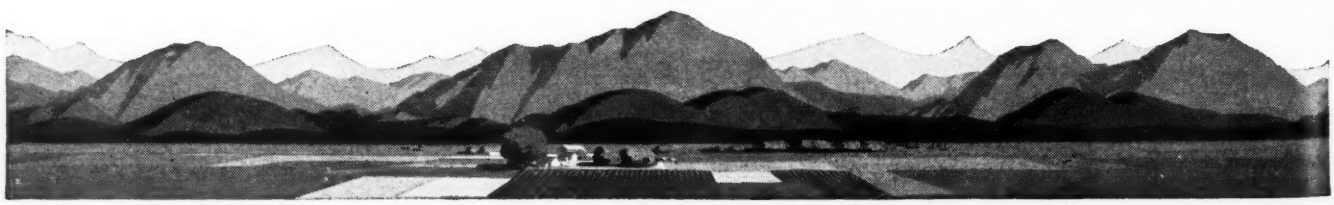

SIDE SLIPS

TAKING CARE of Hump aircrews, particularly those who flew the gasoline tankers, was such a full-time job that the likable Doc never got a chance to fly himself. So it was something of an occasion when he went out one day to go over this same Hump—in a gas tanker at that—just for the ride. Despite some kidding he not only tried his parachute on for fit, he kept it on during what started out as a smooth uneventful trip.

But, as happened so often, they ran smack into some dirty weather, so dirty in fact that the big four-engine converted bomber got whipped into a spin. Somehow, in the first violent twist, an emergency door popped open—and out popped Doc. But the pilots didn't know it till after they'd sweated the plane back on an even keel and the crew chief made his way up to the flight deck, where he reported, in sepulchral tones: "Sir, that captain back there—he's gone."

Fortunately, Doc remembered to pull the all-important little rip cord, and luckily he landed in friendly territory. Within three days that inexplicable native grapevine reported him safe—to the immense relief of the pilots who'd lost him. Yes, he was on the way back to the base, this latter item taking just one month.

So happened the pilots were on hand the day Doc returned and, being an irrepressible pair, rushed up to him and after a very brief and hurried "glad to seeya back" wanted to know "Doc, what the hell was the idea of parachuting out just because we were in a spin?" Think we were gonna pile up or something?"

• Now that reconversion has come and maybe gone, here's one with which to pass the time while waiting transportation to the poorhouse: Just find that little item a fellow requested of us the other day. All the man wanted was "a group picture of the ten most important people in aviation."

• A recent survey reports that not one of the 300,000-odd military pilots need look for jobs in other fields if they want to stay in the flying game. Ninety thousand of the lads, says the survey, will want to stay in the service (have you met one yet?), and the remaining 210,000 will find, among other opportunities, that "10,000 new airline pilot jobs will be available by 1950." Just what the boys are supposed to use to buy groceries for the next five years is ignored completely. Maybe they'll eat up all the surplus K-rations, huh?

• Friend just gave us a wonderful little vintage of 1917 vestpocket book titled, simply, *How To Fly*. Including glossary, illustrations, and marginal maxims, it is 99½ pages long. With great fascination we read the chapter headings—Theory; Grass-Cutting or Rolling; Hopping; Straightaway; Left- and Right-Hand Turn; Figure Eight; Volpiqueing and Volplaning." Right there we stopped, but puzzled only a moment before the meanings of those last two came back. That they "came back" was a jolt as we realized how many years its been since they were common terms.

Move over Methuselah, the old Side Slipper's come to hold yo' hand.

• Woman's work, it seems, is never done—especially in wartime. Friend tells how the cadets at one pilot training school had great difficulty staying awake during the class in aircraft recognition. They used the flash system, under which, in a semi-darkened room, photos of planes are flashed on a screen at speeds running up to a seventy-fifth of a second. The combination of quiet, darkness, and exhaustion from flying and physical toughening was often just too much—the students would begin to doze. So, when the instructor spotted a nodding head he'd quietly change the speed setting—get it down to a fifth of a second, which is a good, long look in such a course. Then, instead of a plane, he put in a slide of a gorgeous nude. Stimulation, he reports, was nothing short of miraculous.

"Maguire got in the wrong department — all he wanted was a 98c. toy plane for his nephew."

Is three hundred-thousandths of an inch too far to go in selling or servicing a plane?

Certainly there are plenty of points in a plane where you have to split a ten-thousandth of an inch several ways. But mirror-polishing the races of the ball bearings in the controls to within 3 hundred-thousandths of an inch . . . isn't that carrying precision to the point of fanatical finickiness?

This is *your question.* The answer has to be *your answer.* Fafnir only makes the bearings . . . to the specifications of aircraft engineers and maintenance men. It's the way Fafnir has met those specifications to the last hundred-thousandth of an inch that explains why Fafnir supplies more aircraft ball bearings than all other bearing makers. And the trend seems to be for shaving precision finer and finer in more and more places in the mechanical operation of planes.

In the matter of mirror-polishing the races of bearings within three one-hundred-thousandths of an inch, the answer is fairly simple. Anything less than such a finish permits quick wear and breakdown of an apparently accurate fit. The "fuzz" worn off acts as a lapping compound; races begin grooving. In no time at all there is enough looseness in that bearing to produce definite backlash, flutter and generally sloppy control. Since that isn't the sort of thing that plane makers and maintenance people want their customers to experience, they seem to feel that a little extra investment in precision finishing of control bearings is a good investment.

However, as we said earlier, this business of how far to go with a hundred-thousandth of an inch is something you have to decide for yourself. But it might be a very good idea to ask your shop men for an opinion. The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR

BALL BEARINGS

For Aircraft

REVIEW OF PATENTS

By A. HARRY CROWELL

Registered Patent Lawyer

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

External Reinforcement Method for aircraft body provided with large doorway openings in side walls utilizes wing structure and its attachment to body to apply external reaction rather than internal reinforcement to resist outward bulging tendency of side wall in doorway region, thus utilizing external structure already present, with consequent weight saving.—2,383,935, filed June 23, '43, pat. Sept. 4, '45, A. G. Dean, assignor to Edward G. Budd Mfg. Co.

Landing Gear Strut has automatically operative locking member which is unlocked by initial motion of retracting motor. Strut has pivot about which it is rotated to effect retraction. And pivotally mounted motor connected to strut rotates with strut during retraction.—2,384,054, filed Sept. 26, '41, pat. Sept. 4, '45, W. C. Trautman, assignor (by mesne assignments) to Bendix Aviation Corp.

Aircraft Engine embodies means for delivering supercharged air to intake manifold and/or cooling jacket surrounding cylinder, so that at certain periods, cooling of engine may be supplemented, while at all times supercharged air may be delivered to carburetor or other fuel mixture system for delivery to combustion chambers.—2,384,381, filed Jan. 2, '43, pat. Sept. 4, '45, D. L. Jocelyn, assignor (50%) to D. G. Jocelyn.

Airfoil Structure of stainless steel has spars and ribs so joined that rib stresses are transferred to spar at intermediate regions of chord members to minimize stress concentration at connections of spar chord members to skin. Joint construction permits securing of parts entirely by welding and in accessible manner.—2,384,409, filed Mar. 6, '43, pat. Sept. 4, '45, M. Watter, assignor to Edward G. Budd Mfg. Co.

Armament Installation for aircraft consists essentially of single strut mount pivotally journalled at one terminal to craft and provided at free end with socket to receive machine gun. Quickly releasable latching device permits free end to be clamped to any of plurality of fixed fittings carried adjacent to each gun port, and overhanging weight of strut and gun are counterbalanced to permit ready swinging of gun and mount from one position to another.—2,384,430, filed July 1, '41, pat. Sept. 11, '45, W. H. Beardslee, assignor to North American Aviation.

Airplane Tire Construction features series of triangular removable cups in similarly shaped vulcanized retainers on outer side wall to automatically rotate wheel by wind pressure when lowering landing gear. Retainer has inward extending marginal flanges along side edges, and cup is provided with reinforced extensions adapted to fit under retainer flanges.—2,383,662, filed Aug. 4, '44, pat. Aug. 28, '45, C. H. McClaskey.

Airplane Pickup Mechanism is designed to be initially set according to load to be projected, with setting automatically changing in accordance with variations in wind velocity, so that article to be picked up will be discharged at proper speed, taking into consideration both weight of article and land speed of plane. Tensioned shock cord device is employed as means for projecting catapult carriage, and windless is used for cord tensioning in accordance with wind velocity variations.—2,383,680, filed June 22, '42, pat. Aug. 28, '45, J. X. Phillips, assignor to G. T. Smith and E. G. Hill, trustees.

Amphibian Aircraft has ground landing wheels arranged non-retractibly in spaced relation to water contact area of flotation members, and there is movable skid means to effectively bridge or unbridge space between water contact area and ground contacting wheel in accordance with landing medium used. Movable skid may merely bridge gap to provide diverting function and deflect water from the wheel or, by imposition on wheel, to cause latter's shock absorbing mechanism to take up water landing shock.—2,383,870, filed July 6, '42, pat. Aug. 28, '45, C. T. Ludington.

Improved-Stability Design for aircraft features low-aspect-ratio airfoil as primary structure and is intended to provide system of stabilizing surfaces and control surfaces in such aerodynamic cooperation with airfoil as to produce desired degree of static and dynamic stability and afford effective control in pitch, roll, and yaw. Substantially all structures and mechanisms are contained within airfoil to reduce drag and other disadvantageous characteristics resulting from exterior location.—2,384,893, filed Feb. 19, '42, pat. Sept. 18, '45, L. H. Crook, assignor to Aerodynamic Research Corp.

Variable Camber Wing permits angular variation of about 3 deg. between front and rear sections, and is fabricated to permit easy access to wing interior throughout construction operation. Hinge, used for pivoting front section to rear section, is disposed at point vertically offset from wing longitudinal axis and comprises pair of brackets, one with horizontal slot. Block slidably disposed in slot is secured to shaft rotatably engaged with other bracket, and lever arm integral with front section is actuated for movement of latter about hinge.—2,384,933, filed Aug. 21, '41, pat. Sept. 18, '45, H. F. Lee.

Aircraft Gun Mounting features cradle support secured to craft at two points about one of which cradle may pivot while other point is capable of axial displacement to permit swinging of gun from

(*Turn to page* 276)

Patents Offered To Aircraft Industry

Now available for licensing are 43 patents relating to various gyroscopic devices and instruments for control and avigation of planes. Patents in question were acquired by the Alien Property Custodian from Askania-Werke, A. G., German manufacturer. Complete list of these patents may be obtained from APC's Patent Use & Development Section, Washington, D. C.

Patents and applications are made available to American citizens on a non-exclusive royalty-free basis upon payment of $15 administrative fee.

Recent Books

THE PAN AMERICAN YEARBOOK, 1945. Pan American Associates, N. Y. C. 829 pages, maps, directories. $5.

Comprehensive coverage of all countries of the western hemisphere, with emphasis on economic and industrial factors. Each country is reviewed alphabetically, with all vital statistics given in key order. Information is valuable for export perspectives.

AVIATION FACTS AND FIGURES, 1945, Ralph Modley, editor. McGraw-Hill Book Co., N. Y. C. 173 pages, tables, index. $2.50.

Reference handbook of pertinent data and statistics on aviation as a whole, with particular emphasis on industry aspects. The book deals extensively with data on the civil and military use of aircraft, exports, service facilities, and the relation of aviation to other means of transportation.

AIRCRAFT PRODUCTION DESIGN, by James E. Thompson. Aviation Press, San Carlos, Calif. 242 pages, photos, drawings, index. $5.

Aircraft production design data is here presented in comprehensive, illustrated form. "It is the hope of the author that this material will assist the aeronautical draftsman and designer to obtain a better understanding of the tools and processes used to manufacture their designs and enable these designs to embody the greatest possible manufacturing practicability and economy."

INTERNAL COMBUSTION ENGINES, by V. L. Maleev. McGraw-Hill Book Co., N. Y. C. 636 pages, drawings, graphs. $5.

This second edition gives the student a practical foundation in the theory, design, and operation of internal combustion engines. Added are five entirely new chapters which concern combustion in spark-ignition engines, combustion in compression-ignition engines, compression-ignition combustion chambers, supercharging, and gas turbines. Featured by the book are the application of theory to current practice, the wide scope of the material, the variety of illustrations, and design introductory material.

AMERICAN MACHINISTS' HANDBOOK AND DICTIONARY OF SHOP TERMS, by Fred H. Colvin and Frank A. Stanley. McGraw-Hill Book Co., N. Y. C. 1,546 pages text, graphs, drawings, supplement, index. $5.

Eighth edition of this widely used standard manual comprising data, methods, and definitions for apprentices, machinists, toolmakers, draftsmen, designers, foremen, superintendents, and all others active in the shops and drafting rooms of the metal-working and allied industries. The work has been considerably expanded.

AVIATION: WHAT EVERYONE SHOULD KNOW, by Devon Francis. Bobbs-Merrill Co., N. Y. C., 229 pages, photos, glossary, directory, index. $2.50.

A lucidly written discussion and exposition of aviation from the ground up, offering interesting information in non-technical form. Well-illustrated.

THEORY OF STRUCTURES, by S. Timoshenko and D. H. Young. McGraw-Hill Book Co., N. Y. C. 448 pages, diagrams, index. $5.

First chapter of this volume offers an introduction to the theory of structures, with the basic principles of statics recapitulated. Succeeding chapters deal with the analysis of statically determinate trusses in one plane, influence lines, formation and analysis of space trusses with hinged joints, principles of mechanics preparatory to the analysis of statically indeterminate structures, methods of calculating deflections of trusses, theory of statically indeterminate trusses, bending of beams and frames, and the theory of arches.

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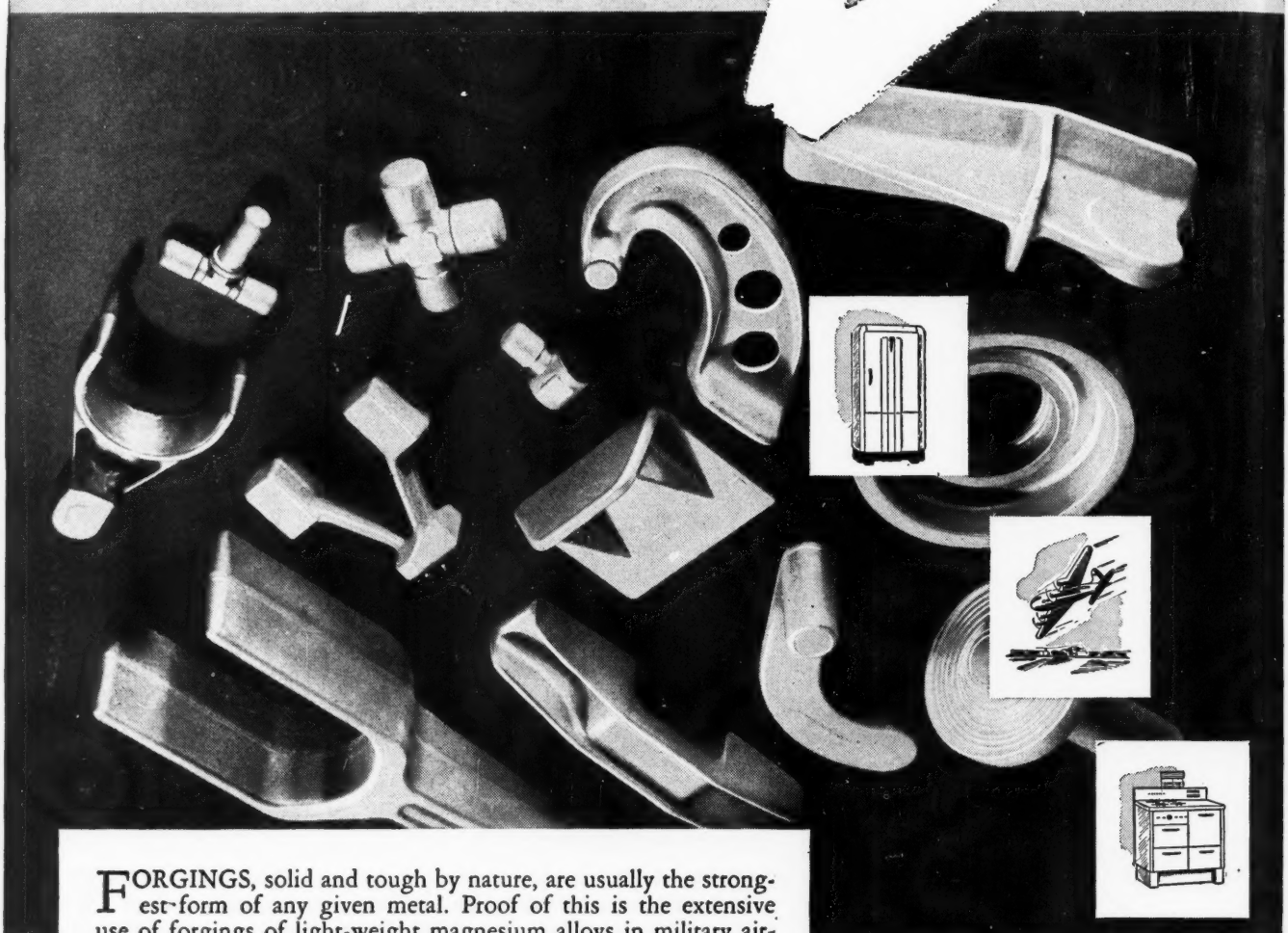

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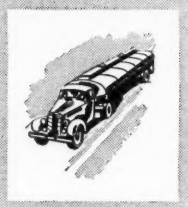

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THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York E. J. BULBAN, New York

Leaders Drive to Unify Our Military Forces; Affirmation Likely Despite Navy Opposition

. . . Billion dollar airfield bill readied for signing . . . Symington heads SPA; faster action seen . . . Advisors move to simplify control of N-S flying . . . CAA gages next 10 yr . . . Tour seen attracting 1,200.

Unification of Army, Air Forces, and Navy under a single Department of Armed Forces headed by a civilian of Cabinet rank is favored by nearly all Army field commanders, while being opposed by about half the Navy's battle commanders. Several bills to effect such unification are pending before Congress, and affirmative action seems probable despite the battling as this is written.

Both Army and Navy have proposed unification plans before Congressional hearing committees. Navy Secretary James Forrestal's recommendation that the State Department be tied in with the military met pronounced disfavor.

Army proposes that, under the Secretary of Armed Forces, there should be a Chief of Staff of the Armed Forces, and under him three Chiefs of Staff, for the Army, Navy, and Air Forces. Land, air, and sea powers would have equal status. The Navy would retain its Fleet Air Arm, and its Marines.

The Navy is already essentially an air force in itself. Thus, under the Army's proposal, there would be a sea-based air force; a land-based air force; and a ground force. Complications between the Naval air power and the Air Forces are foreseeable. The land forces would retain certain specialized aviation, such as liaison, transport, and communications. Many authorities have said that major ground forces will move by air, but that is something in the future.

Main objective in the unification proposal is the modification of jealousies, duplications, and misunderstandings by making all defense personnel responsible and loyal to the same top authority. Duplication in design, especially of aircraft for certain purposes, though never yet achieved, is desirable.

Hearings were before the House Committee on Postwar Military Policy and the Senate Military Affairs Committee. Nearly all Army generals, including Marshall, Eisenhower, Arnold, and others, have approved unification. Before he was President, Mr. Truman spoke for a single defense office, but as chief executive he has not, at this writing, made any commitment.

Billion Dollar Airfield Bill Readied for Signing

With the House following the Senate's lead (Nov. AVIATION), Congress has now passed bills providing for a national airport development program to cost about one billion dollars. The two bills were in joint conference committee at this writing and probably will be enacted into law before press closing time.

Senate trimmed the McCarran proposal down to $750,000,000, but the House sustained Rep. Clarence Lea in his call for $1,300,000,000. The amount voted will be matched with equal sums in State money, and spent over a period of about 10 yr. The program is designed to add about 3,000 airfields to the existing 3,000, the latter to have extensive improvements. Because most of the big fields needed by air transport have been built, most of the new program is devoted to smaller fields for feeder and non-scheduled aviation.

Symington Heads SPA; Faster Action Seen

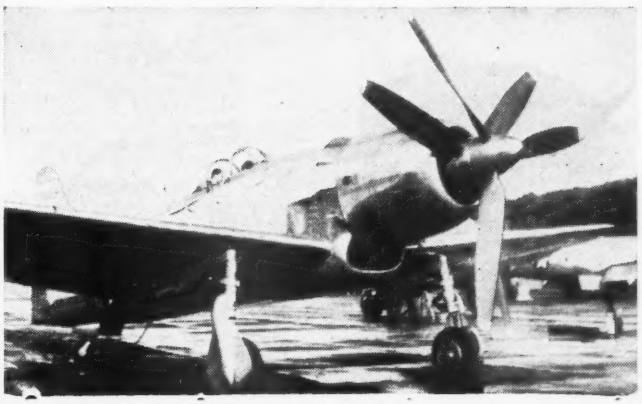
Surplus Property Administration, responsible for policy in the disposal of mountainous war surpluses, including about $10,000,000,000 worth of aviation products, is now headed by a single administrator, W. Stuart Symington, rather than the former three-man board.

Instead of going to Congress for revision of the law, Symington is seeking quick action through an administrative streamlining. His policy is: That airplanes suitable for civilian use must be moved quickly, before they are completely obsolete, on the best terms possible; very few engines can be sold for aviation use; other markets must be investigated; and normal trade must not be threatened, even if wholesale scrapping is necessary; more attractive sale and lease terms should be devised for disposal of plants; tools are moving satisfactorily, but should be cleared from plants more expeditiously.

RFC, which is charged with many duties other than surplus-property disposal, has organized a War Assets Corp. which will take over RFC's disposal functions. RFC recently was given those categories of surplus formerly handled by the Commerce Department, and thus was being swamped. It is expected that WAC will facilitate SPA's fast-action policy.

Recent transfer of the Army-Navy Liquidation Commission, which handles all military surplus sales abroad, from FEA to the State Department, will have little effect on ANLC's operations. The transfer order permits Army and Navy to assign their officers to the work, and the officers are merely detailed to State Department instead of FEA.

SPA meanwhile announced



POCKET-SIZE FLYING FORT

Closeup view of new Boeing XF8B-1 Navy fighter shows neat "power pack" mounting of 3,600-hp. P&W Wasp Major engine turning six-blade contra-rotating prop. Credited with top speed in excess of 450 mph., single-seater can carry a 6,400-lb. bomb load or two 2,000-lb. torpedoes, in addition to six 20-mm. cannon or six .50 cal. guns. Gross weight is over 6 tons. Specifically designed for long-range operations, many pilot-comfort features have been incorporated. Monospar wings, fitted with Fowler-type flaps, are thick-skin covered to provide torsional stiffness. (Press Assn. photo)

COMING UP

Dec. 3 - 5: SAE National Air Transport Engineering Meeting, Edgewater Beach Hotel, Chicago.
Dec. 8: Sportsman Pilots Assn. Meeting, Carolina Hotel, Pinehurst, N. C.
Dec. 10 - 11: ADMA Meeting, Hotel Statler, Cleveland.
Dec. 11-12: Western Aviation Conference, Sacramento, Calif.
Dec. 13 - 14: Airline Finance & Accountant Conference, Dallas.
Dec. 16 - 17: International Aviation Day, El Paso.
Dec. 17: IAS Wright Brothers Lecture, Washington, D. C.
Dec. 17: Award of Collier Trophy, auspices NAA, Washington, D. C.
Dec. 26-Jan. 20: Annual Light Airplane Tour to Florida.
Jan. 4 - 6: All-American Air Maneuvers, Florida Air Races, Miami.
Jan. 7 - 11: SAE Annual Meeting & Engineering Display, Book-Cadillac Hotel, Detroit.
Jan. 11 - 20: Cleveland Aircraft Show, Public Auditorium, Cleveland.
Jan. 28: IAS Honors Night Dinner, Waldorf-Astoria Hotel, N. Y. C.
Jan. 29 - 31: IAS Annual Meeting, Pupin Laboratory, Columbia University, N. Y. C.
Feb. 4 - 7: American Welding Society National Meeting, Hotel Cleveland, Cleveland.
Feb. 4 - 8: National Metal Exposition, also National Metal Congress, Public Auditorium, Cleveland.
Feb. 4 - 8: American Society for Metals' postponed 1945 Annual Convention, Statler Hotel, Cleveland.
Feb. 4 - 8: American Institute of Mining & Metallurgical Engineers, Iron & Steel and Institute of Metals Divs. National Meeting, Statler Hotel, Cleveland.
Mar. 1-5: Pan American Aircraft Exposition, Dallas.
Apr. 3 - 5: SAE National Aeronautic Meeting, Hotel New Yorker, N. Y. C.
May 7 - 9: National Assn. of Corrosion Engineers, Annual Meeting and Convention, President Hotel, Kansas City, Mo.

formation of two new advisory committees—the Aircraft Manufacturers Industry Advisory Committee and the Air Transport Industry Advisory Committee.

Advisors Move to Simplify Control of N-S Flying

An important step toward simplification of control over non-scheduled aviation was taken when the Non-Scheduled Flying Advisory Committee, appointed months ago by CAA Administrator Wright, recommended that approved aircraft maintenance shops be authorized to certificate planes for air worthiness after repairs, annual inspections, etc.

A subcommittee was named to outline the Committee's opposition to economic regulation of non-scheduled commercial flying, and negative opinions were expressed regarding many provisions of the proposed Part 42 which would set up safety regulations for non-scheduled carriers.

Other actions taken: Suggested that CAA discontinue the designation of airports; approved CAA's proposal that two pairs of radio channels be allocated to private aviation, and named a radio subcommittee to promote the interests of personal flying with federal and industrial radio agencies; opposed numerous proposed restrictions on non-scheduled flying.

CAA Gages Next 10 Yr.

CAA's *Civil Aviation and the National Economy*, priced at 55¢ from the Government Printing Office, forecasts a 30% annual increase in aircraft as they acquire greater utility and as more airports are provided. The study says that by 1955, depending upon good federal promotion 280,000 planes will be used for personal business and recreation; 40,000 by business concerns; and 80,000 by commercial services.

A total of 901,300 jobs in, or created by, aviation is predicted for 1955, compared with 142,300 in 1939.

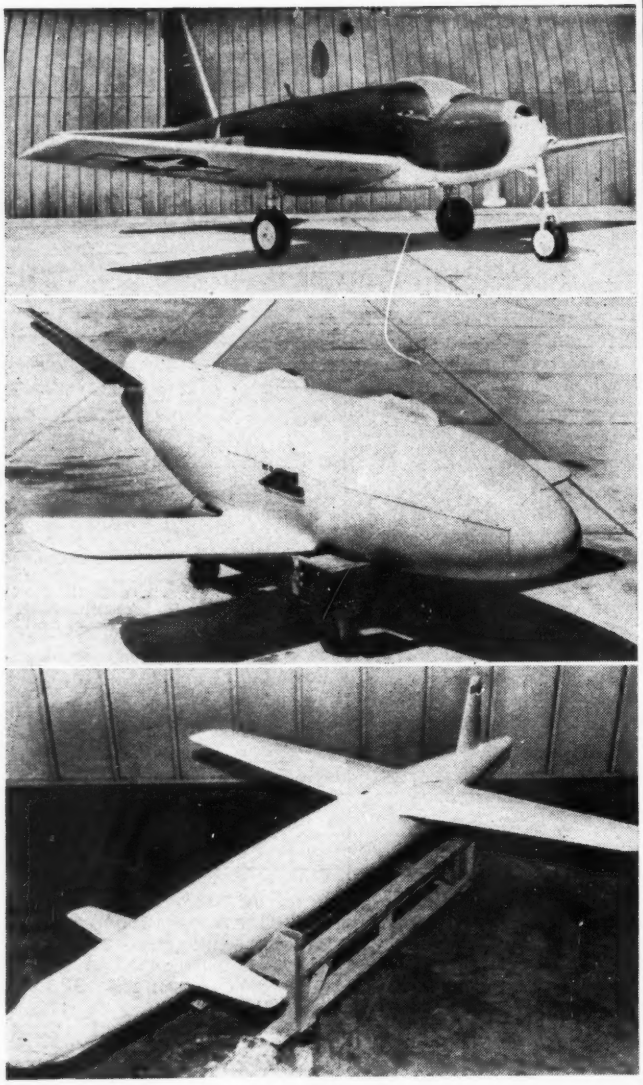
Annual passenger revenue of $345,000,000 is forecast for the airlines, 5% of the total expected to be spent on all forms of transportation. Airline traffic would be 50% of Pullman mileage.

Fly-Ur-Self Resumes

Offices have been opened in N.Y.C.'s Woolworth Bldg. by National Fly-Ur-Self System, announces Howard T. Ailor, president. A nation-wide network offering airplane rental and charter service with both two- and five-place planes is planned. It will be possible to rent a craft at one base and leave it at another. Further, lower rates than those prevailing before the war are promised.

Tour Seen Attracting 1,200

Lightplane flying stimulation is seen in the renewal, this winter, of the Annual Light Airplane Tour to Florida, scheduled Dec. 26 to Jan. 20. With Gulf Oil sponsorship, and eleven plane makers participating, some 1,200 craft from all states east of the Rockies are expected to take part, this figure being based on participation of 1,400 planes in the last tour in '41. Gulf will furnish free gas and oil, both going and returning, at more than 50 specified fields on the various routes.



NO PILOTS NEED APPLY

These photos depict Navy developments in pilotless missiles, indicating that service is not overlooking any bets. At top is "Glomb" glider-bomb, which, loaded with 4,000 lb. of explosives, can be towed by a fighter plane. Control, after release, is by radio and television. "Gargoyle" (center) is jet-propelled, does better than 600 mph., carries a 6,000-lb. armor-piercing warhead, and automatically seeks its target. Rocket-powered "Gorgon" (above) has a top speed of over 550 mph. and can be carried by a bomber. This type is radio-controlled or sent toward objective using its own auto target seeking device. (Press Assn. photos)

★ SPOT CHECKING ★

National Aircraft Show, scheduled to be held in Cleveland's Public Auditorium Jan. 11-20, promises a large variety of U. S. military and civilian craft, plus captured German and Jap types, in addition to all types of instruments and devices used in war. Noted aviation figures will speak. Proceeds will go to AAF Aid Society.

World record attempts in aircraft field, called off during war, are now resumed, with British Gloster Meteor jet-job filing first claim in postwar series with a 606 mph. performance. Pilot of twin Rolls-Royce Derwent gas turbine craft was Group Capt. H. J. Wilson. Listed world speed mark is 469.2 mph. flown in 1939 by Germany's Fritz Wendel. His plane was an Me-109.

Challenge to American aviation industry and public and private educators to assist in maintenance of world peace and to help promote new heights of cultural and economic well-being was voiced at recent Denver Congress on Air Age Education. Sponsored by Social Science Foundation of U. of Denver, week-long conference attracted both aviation experts and educational leaders from all parts of country. Called for was a "kindergarten to post-graduate" air education program, with accent on question "How can the airplane best serve mankind?"

New unofficial U. S. altitude record was made with Bell P-59 Airacomet, when craft reached 47,700 ft. carrying full military load.

New sales policy has been inaugurated by RFC on surplus planes disposal, with 20% reductions available to buyers of three or more training craft, including twin-engine Cessnas, together with a broadening of price ranges on primary trainers and Cessnas to better account for difference in condition and cost to buyer in readying craft for certification. Ferrying allowance of 27¢ per mi. will be allowed on price-tagged planes, up to $90 maximum. Thus far, RFC reports, 4,200 primary trainers have been sold since Jan. 1, with 4,137 still in stock.

Veterans Administration will probably change a regulation so that vets can take flight training in a regular college course paid for under GI Bill of Rights. As NAA defines it, regulation provides that a recognized educational institution shall judge what elective courses properly come into a program of study under GI Bill. However, Administration field auditors refused to authorize payment of a $175 bill incurred by Wichita University in providing flight work for a student.

New line of aviation gasolines, designed to increase permissable power and lower engine maintenance costs, has been introduced by Colonial Esso Marketers. Grade 80, for personal craft, is clear 80 octane without tetraethyl lead. Grades 91 and 100 are stated to give higher permissable takeoff power and to have lowered lead content.

B-50 is latest version of Boeing's superbombers. Craft is powered by P&W Wasp Major R-4360 engines, has lighter landing gear, lighter wings, new and larger vertical tail surfaces, and reversible thrust propellers.

Seen at recent Wright Field AAF fair was Fairchild XBQ-1, a radio-directed flying missile with a 4,000-lb. warhead. Craft is similar in appearance to company's AT-21. Also present was Cornelius XFQ-1, a fuel-carrying glider, designed to be towed behind bombers for mid-air refueling so as to extend tactical range. Craft can be either pilot- or radio-controlled. Featured are sharply swept forward wings.

National record for sustained flight of two-place sailplanes was made by Paul A. Schweizer and Franklin E. Hurtt when they recently piloted a Schweizer TG-3A for 9 hr. 17 min. over Harris Hill, Elmira, N. Y. During Labor Day weekend, 72 pilots and more than 20 gliders made flights from Harris Hill.

Mass movement of troops by air was amply shown when 433rd Troop Carrier Command flew over 30,000 men of Chinese 6th Army 633 mi. from Chihkiang to Nanking. Curtiss C-46s, loaded to capacity, were flown from dawn to dusk for 25 consecutive days, and transfer was completed almost three weeks ahead of schedule.

First downtown helicopter landing area in West is to be built atop Hilton Hotel, Long Beach,

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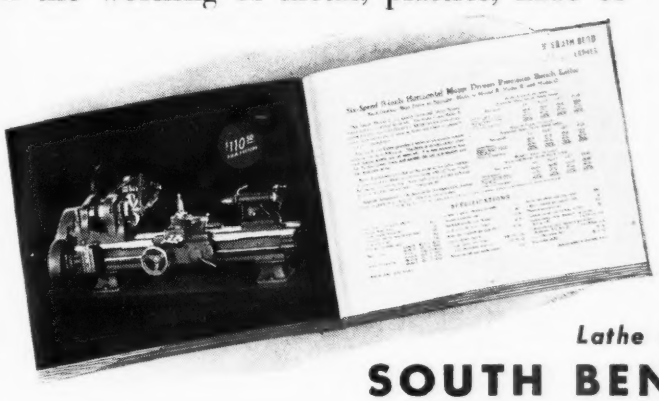

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KELLETT—
SUBCONTRACTOR

Calif., as part of $1,250,000 addition. Landing deck will be erected above supper club, and a control tower is to be built in front of hotel at deck level.

Axial Flow Compressors is listing of expanded jet propulsion course now being offered at Polytechnic Institute of Brooklyn, N. Y.

REA observed 35th anniversary of air express, recalling first shipment, consisting of five bolts of silk worth $1,000 and weighing 60 lb., from Dayton to Columbus, via a two-placer Wright biplane. Craft covered distance of over 65 mi. in 66 min. Entire movement of cargo, including rail **shipment from** N. Y. C. to Dayton, **then by** air to Columbus, **took 23 hr.** Company states that **now journey** takes less than 4 **hr. by** modern air express.

First successful non-stop flight between Hokkaido, Japan, and Washington, D. C.—6,544 mi.—was made by four Boeing B-29Bs. Total of 43 men made run, the best takeoff-to-landing time being 27 hr. 33 min. Best speed reached on trip was 290 mph., and lead plane still had 500 gal. of fuel left after landing, stated to be enough for 3 hr. more flight. Craft is latest model of the Superfortress, stripped of all sighting blisters and all turrets except for tail, which has three .50 cal. guns. Modifications add at least 10 mph. to stop speed and boosted bomb load by 3,000 lb. on long missions.

★ CALLING NAMES ★

Fred L. Clark has been named TACA asst. agency mgr., and Paul Collins has been appointed airline's personnel director.

TWA appointments: **Warren Lee Pierson** has been elected a director; **E. Lee Talman** was named senior v.-p.; **Brig. Gen. T. B. Wilson** becomes managing director of new international div.; **Lt. Col. Joseph W. Letzkus** became transportation mgr. for midwest region; and **Carl A. Finkbeiner, John A. Lundmark,** and **Stan Favour** were named staff assistants in K. C. cargo sales dept.

Col. Rex Smith has been appointed director of public relations for AA; **L. G. Fritz** has been elected v.-p.; and **Harley P. Hallock** has been made asst. to regional v.-p. in Texas.

Col. Richard E. Pfennig resumed his post as UAL regional v.-p. of operations; and **Gail Borden** was named asst. to pres.

William P. Hildred, British Director of Civil Aviation, has been elected director general of IATA.

W. Fields De Groat joined design engineering staff of Kellett.

Maj. Robert S. Fogg joined Edo Aircraft and will be in charge of commercial float sales.

C. F. C. Meuser has been named U. S. rep. for Royal Dutch Airlines (KLM).

T. P. Wright has been elected v.-p. of NACA, and **Dr. J. C. Hunsaker** was re-elected chairman.

Walter R. Macatee has been appointed mgr. of Airport Div., American Road Builders Assn.

Col. George H. Moriarty has been made chief of Airports Components Disposal Section, Aviation Div. of RFC.

Joseph J. Mitchener, Jr., has been appointed exec. director of Feeder Airlines Assn.

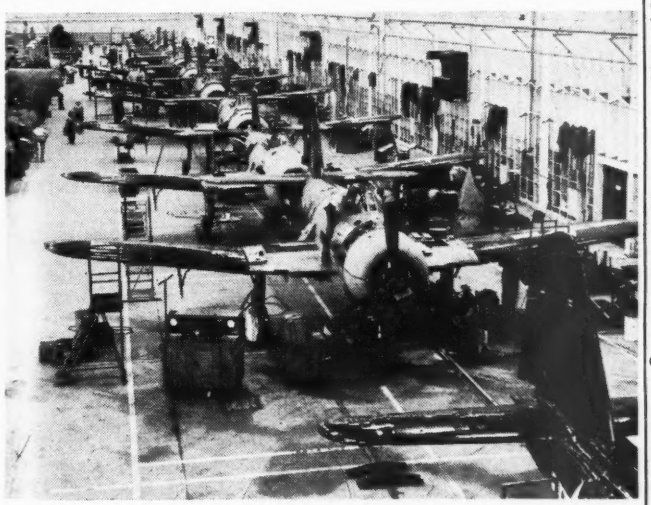
Sheldon B. Steers resigned post of Director of Aeronautics for Michigan.

George W. Pfeil, publisher of McGraw-Hill's transportation magazines, announces appointment of **James C. Anthony** as Chicago district mgr. for AVIATION, *Aviation News,* and *Air Transport.*

Dr. Louis G. Feman has been promoted to general mgr. of I. Miller Parachute Div.'s Long Island, N. Y., factory.

F. C. McMullen, of Western Electric, has been appointed chairman of Aviation Radio section of Radio Manufacturer's Transmitter Div.

PAA appointments: **Robert J. Gleason** has been named communications supt. of Pacific-Alaska Div.; and **Warren Adams Pine, Jr.,** has been made airline's special rep. for Cuba.



RYAN'S 'BALL LINE

Here is Ryan's final assembly line for bluestreaking FR-1 Fireball fighter. At far end are fuselages with center sections attached. As planes progress along line, landing gears, tail surfaces, outer wings, and propellers are fitted. In foreground can be seen stands for testing instruments and hydraulic equipment.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Some air transport authorities believe time is being wasted in bickering between U. S. flag concerns and between the U. S. and Britain, while more than the estimated traffic is waiting to be carried.

Military air force leaders are worried lest the public and Congress divert too much attention too soon from existing equipment and weapons to space missiles and to other wizardry which is still some years from reality.

Even the cloistered basic researchers now say that persons can ride flying machines that will outrun the earth's rotation within a few years. Extravagant fuel consumption will be compensated by speed, enabling the new aircraft to make two or three transcontinental round trips per day. A trip started westbound at sunset, say, would be in sunset all the way. (The Advertising-Jingle-of-Tomorrow Award to Blaine Stubblefield —Editor.)

A certain admiral, talking ten minutes at a recent large aviation meeting, stated (1) that military lighter-than-air is out; (2) that battleships are merely A-A gun platforms; and (3) that flying boats, except for personal use, are on the wane.

Big talk, mostly double, for bigger and better war and for world peace all at once, is Washington's biggest problem, complicated by the atomic bomb, for which the best answer, for the most people, would be a sudden, strickening by mass amnesia of all those who know how it works.

A government research official said: The ram jet, simplest of engines, will be "improved" till it is more complicated than any existing engine.

The proximity fuse tiny radio-radar set in the nose of a shell, causing detonation when near the target, will make air attack, in areas defended by such A-A fire, extremely difficult.

Joseph A. Uhl has been named secy-treas. of CAL, and **John E. Cook** has been made general traffic mgr.

William L. Rome has been appointed exec. v.-p. of Air Cargo Transport Corp.

Lt. Col. Nathaniel F. Silsbee, joined Henry Publishing Co. as technical editor.

Verne C. Milligan has been appointed Mid-Continent Airlines' supt. of passenger service.

John S. White has been named personnel director for C&S.

Marshall C. Hoppin resigned from CAA to become pres. of Alaska Airlines.

Col. Thomas A. Murphy has been named aviation industry mgr. for Reynolds Metal Co.

Hugh McL. Fenwick resigned as general sales mgr. for Hughes Aircraft in order to organize and head his own business.

P. K. Macker, public relations director for NAA, has been elected chairman of western public relations committee of AIA; and **Dale Armstrong** is new vice chairman.

R. J. White has been put in charge of aircraft radio and radar equipment sales for Philco.

Col. William Tudor Gardiner has been elected to NWA's board of directors.

R. C. Cosgrove has been named v.-p. in charge of sales for Avco.

Glenn L. Martin appointments: **G. T. Willey,** v.-p. planning materiel; **D. W. Siemon,** mgr. of

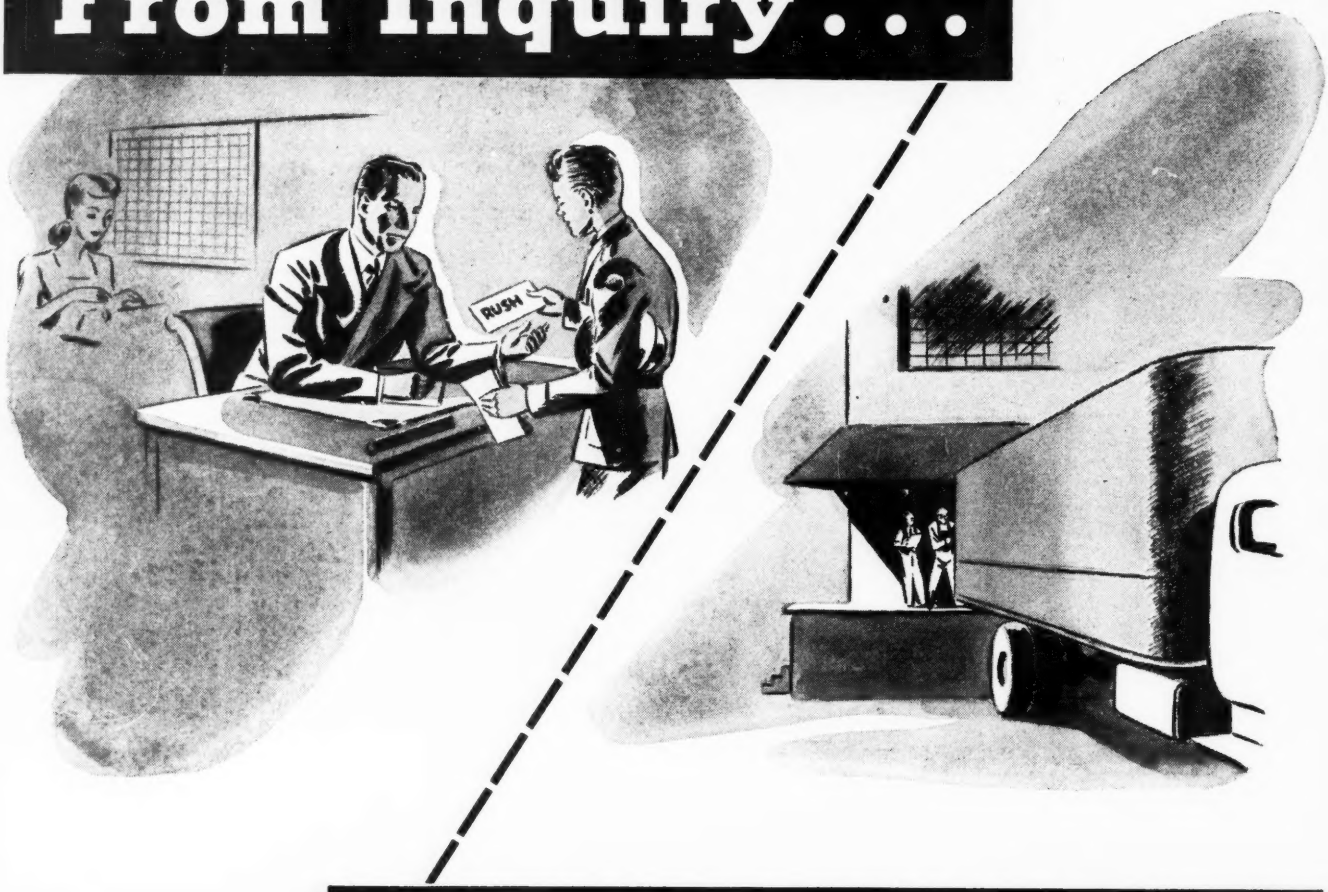
(*Turn to page* 231)

★ OBITUARY ★

Col. Lowell H. Smith, prominent figure in military aviation. He commanded and completed the Army's 1924 globe girdling flight in Douglas World Cruisers following loss of original command plane, and also set many speed and endurance world records for military craft. In decade preceding World War II, he participated in planning of massed airborne trooper landings and piloted first plane for massed parachuting. In World War II he was engaged with training of heavy-bomber crews. For his various achievements, he received many decorations.

John C. (Jack) Nichols, TWA v.-p. in charge of international operations. A former lawyer, he served as member of House of Representatives from 1934 to 1943, before joining TWA.

From Inquiry . . .



to Delivery . . .

Michigan Seamless Service Is Personal and Fast

Every inquiry gets prompt, personal attention at Michigan Seamless Tube Company. Realizing the urgency of most requests under today's manufacturing conditions, our organization is trained to act quickly in interpreting your specifications or in developing the proper tubing to meet your need.

And we have repeatedly demonstrated our dependability in living up to agreed-upon delivery schedules. Our service carries straight through from inquiry to delivery.

We invite an opportunity to discuss tubing applications with you. Write or wire us about your needs, or consult our nearest sales office.

COLD-DRAWN SEAMLESS STEEL TUBING

AIRCRAFT • MECHANICAL • PRESSURE • STRUCTURAL

MICHIGAN SEAMLESS TUBE COMPANY

SOUTH LYON • MICHIGAN

ARMY E NAVY

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Chicago • Denver • Los Angeles • St. Louis • Seattle

Eight-Point Program for Aviation Industry Offered by New Air Coordinating Committee

. . . AIA advises procedure . . . Tunnel shortage noted; tech data released . . . New research-bill move . . . Ship new Continentals; plan engine-rebuild service.

A program "to insure the existence of an aircraft industry capable of rapid expansion to keep the peace and meet any emergency," has been proposed to the Senate Military Affairs Committee by the newly-formed Air Coordinating Committee, representing State, War, Navy, Commerce Departments, and CAB. Accenting eight points, the report was written by a subcommittee on demobilization of the aircraft industry.

1: Experimental versions of aircraft for military use must be thoroughly engineered and tested, ready for large-scale production.

2: Minimum program to serve as a base for expansion should be 3,000 airplanes having an airframe weight of 30,000,000 lb.

3: Government should make surplus plants available to aircraft industry on favorable terms which give recognition to present low level production.

4: Major portion of aircraft plant dispersion achieved during World War II should be preserved.

5: Army and Navy should organize an aircraft production expansion program, which would cost no more than $5,000,000 a year.

6: Army and Navy should own, and be able to convert quickly to aircraft production, specialized airframe and engine plants totaling at least 26,000,000 sq. ft.

7: War and Navy Departments should own a reserve of 65,000 general purpose machine tools.

8: An efficient intelligence service to warn against attack, an industrial mobilization plan, and an overall raw materials and prefabricating capacity backlog, will be necessary to make this program effective. Programming for shipbuilding, ordnance, munitions, communications, should be coordinated with air.

Plants in the following locations are recommended for the airframe reserve: Fort Worth, Kansas City, Marietta, Omaha, Tulsa, owned by War Department, and Columbus, Dallas, Louisville, St. Louis, and Wichita, owned by DPC. Recommended reserve engine plants are in Chicago, Indianapolis, Kansas City, Lockland, Melrose Park, and South Bend, all Army owned. DPC-owned plants would be transferred to Army or Navy. Recommended machine tool reserve is broken down by classes.

AIA Advises Procedure

Aircraft Industries Assn. has proposed to Senate Military and Commerce Committees: (1) Congressional appropriations in support of research in aeronautics and allied problems; (2) a program of aircraft procurement adequate to prove out developments and capable of rapid expansion; and (3) encouragement of private enterprise to produce military products free of discriminatory tax, patent, and export, or other control not imposed on other industries.

Tunnel Shortage Noted; Tech Data Released

Military aircraft in the super-performance category will need "five times as much research data in the next six months as can be obtained from the existing high-speed wind tunnels," said Russel G. Robinson, NACA's chief research coordinator, in a statement before Congress appropriations committees.

Over 300 NACA technical reports have been declassified for general availability in the aeronautical industries. Rep. Clarence Cannon, chairman of the House appropriations committee, recently argued that aircraft manufacturers should be required to pay for basic work done by NACA. Dr. J. C. Hunsaker, NACA chairman, countered that the work is primarily for the military, and that benefits to commercial aviation are in the public interest.

Army and Navy both are calling for large sums for their air research—and Congress has been cutting them down.

New Research-Bill Move

The President has proposed a compromise of the Kilgore-Magnuson bills for the creation of a national research foundation which would coordinate, and support with federal funds, development work in all lines of science by private and government agencies.

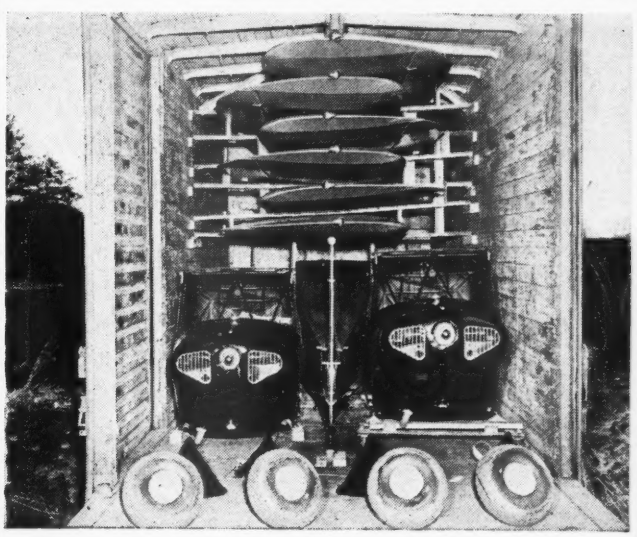
Mr. Truman's views, contained in a letter from Reconversion Director Snyder, called for: (1) A single full-time administrator with a full-time advisory board of scientists; (2) coordination to provide a balanced program; and (3) a uniform patent procedure, the results of federally financed work to become government property, available to all. Most scientific researches affect aviation one way or another.

Ship New Continentals; Plan Engine-Rebuild Service

Deliveries on its new post-war 6-cyl. lightplane engines have been begun by Continental. The aircooled, horizontally opposed power plants comprise a series similar to the group of 4-cyl. 65, 75, and 85-hp. models, however 100, 115, and 125-hp. will be afforded. Early next year, addition of 6-cyl. models in 150, 165, 185, and 210-hp. categories is expected, states company.

Also in production, states Pres. C. J. Reese, are 7- and 8-cyl. radials. Former is basically the R-670 made during war and rated at 220-240 hp. Latter, to be used on feeder-liners made by a large manufacturer, is rated at 525 hp.

Meantime, Continental is working out final details of its plan to provide plane owners with a moderate-cost factory engine-rebuilding service. Program calls for coordination of such work through local distributors, who would get usual discounts and commissions.



TAYLORCRAFTS BY THE CARLOAD

Neatly stacked, first carload of personal craft to be shipped since Pearl Harbor, is sent by Taylorcraft to Northwest Aircraft Distributing Corp., Vancouver, Wash. Six planes can be stowed in a car. With wings, struts, and landing gear removed, craft weigh about 500 lb. each and are readily handled by six men. Planes shown are BC12Ds, selling at $2,295. Company states that orders are on hand for over 7,000 planes, with schedules calling for delivery of 600 or more by this month.

★ INDUSTRY MEMOS ★

Northrop contracts for development of XB-35 and YB-35, four-engine flying wing bombers, are being continued. Company states that 12 experimental flying wing craft have been flown since '40. AAF has also given Northrop contracts for jet-driven projectiles and for rocket launching sleds.

Republic received orders from PAA to convert 20 more Douglas C-54's into passenger airliners. Company already is working on conversion of 50 C-54's for AA.

Fairchild Camera & Instrument Corp. has been appointed agent for RFC in sale of surplus aircraft avigational instruments and aerial cameras.

First postwar Ironite ironer to arrive in N. Y. C. territory was shipped by maker via air express to company's exclusive distributors.

Further experimental work on Hiller-Copter is to be carried out by Kaiser Cargo, Inc., at company's Fleetwings Div. Aircraft Plant in Bristol, Pa. It is stated that Stanley Hiller is no longer connected with this project, but instead has formed new United Helicopters, Inc.

Special flying devices capable of speeds over 1,400 mph. have been developed by C-W. Aside from word that they are pilotless and are not rockets or shells, no details were released.

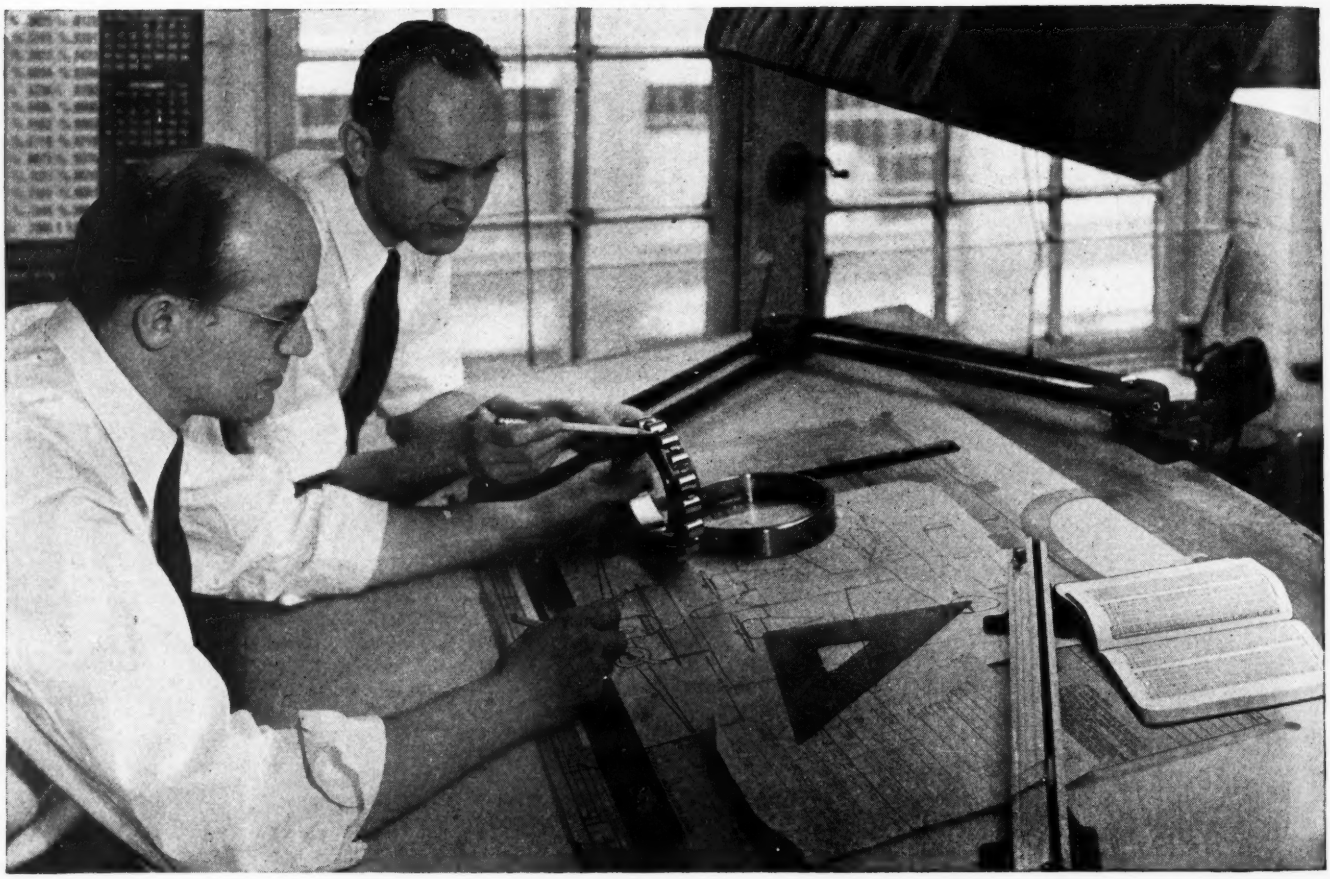
National sales demonstration of Bendix Flightweight low-cost personal plane communications equipment includes "tele-flight" device containing a complete cockpit layout and projector screen, giving occupant illusion of taking off, flying, and landing.

NACA's Subcommitte on Wood & Plastics for Aircraft met at C-W's research laboratory, primarily to discuss "sandwich construction" using these materials. It is stated that such construction holds real promise in future high-speed aircraft design, with important strength gains and weight savings. Super-thin sheets of steel, aluminum, or high-strength glass fabrics might be used as faces bonded to balsa or foamed plastic, obviating present internal strengthening members which limit space and add weight.

Six aircraft plants are offered for sale or lease by RFC: Lawrance Aeronautical Corp., Linden, N. J.; Douglas Aircraft, Los Angeles; Fairchild Engine, Jamaica, N. Y.; Thompson Air-

FOR YOUR INFORMATION....

Human Handbooks of Bearing Data



FOR MORE THAN 50 YEARS, Hyatt engineers have been literally "walking encyclopedias" of bearing information for manufacturers of machines and equipment, and their designers.

During this time these men have accumulated a tremendous fund of technical knowledge of the application of Hyatt Roller Bearings. In this vast reservoir of experience, there may already be solutions to the mechanical obstacles that you encounter in the products you are developing or improving today. Even if there has not been a problem to parallel yours, these highly skilled specialists are more than likely to bring up the right answer...one that will contribute to both operation and less costly designs.

Consultation with Hyatt engineers is easy to arrange, involves no obligation. They are glad to come to you in a spirit of interested helpfulness and proud of the opportunity to work constructively with you in the selection of proper bearings for your products. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

craft Products, Euclid, Ohio; G.M.C. Buick Div., Flint, Mich.; and American Aviation Corp., Jamestown, N. Y.

War groups now dissolved include ATSC's Aircraft Scheduling Unit, announces Brig. Gen. E. W. Rawlings, procurement chief. Also abolished is Joint Aircraft Committee, American-British body which had Allied war powers to schedule deliveries of aircraft and components.

AIA has told Congress that continued drafting of young, qualified areo engineers is seriously interfering with research and development programs. One company lost 5 engineer specialists in October and has 25 others subject to induction, while it is working on more secret military projects than ever before. Three other companies have 49, 23, and 7 engineers subject to draft.

Traditional military unit order of 13 craft would be raised to 30 up to 200 units if there is a follow-through on a recommendation recently presented to Congress by East Coast aircraft executives. Latter called for continuation of research and development in sphere of volume production, supported by procurement for thorough test.

National Planning Assn. concurs in aircraft programs sponsored by the aviation industry, holding bright prospects for volume demand for private and non-scheduled aircraft.

Current Backlogs: Northrop, $51,000,000; Convair, about $222,000,000; NAA, $31,000,000; Douglas, about $151,370,000; United Aircraft, about $130,000,000; Fairchild, about $88,000,000; Republic, about $50,000,000; C-W, about $115,000,000; and Bell, about $34,000,000.

Martin received orders from PCA for 35 Model 202 airliners, with deliveries to start early in '47. Contract totals $7,000,000 . . . Martin also is converting 20 Douglas C-54's into 54-passenger airliners for EAL.

Aircooled Motors received orders from Convair for 1,000 Franklin 150-hp. engines, presumably for installation in Stinson 150 Voyagers.

Intensive pre-production advertising campaign is stated to have brought Ercoupe 10,000 advance orders for company's two-place personal plane. Campaign, costing an estimated $50,000, was carried out in aviation papers, magazines, and newspapers. Dealers are being sent elaborate kits of mats, direct mail pieces, and publicity plans.

Publications: IAS newly issued '45 Aero Engineering Catalog, containing specifications and engineering data on wide variety of aircraft products and listing sources of supply for over 2,000 items . . . "For Wider Horizons" is Bendix booklet dealing with new personal plane radio aids in non-technical manner. Illustrations and text explain uses and benefits . . . Details from recent hearing which developed eight-point program to insure existence of an aircraft industry capable of rapid expansion in case of need, have been assembled in "Report to the Air Coordinating Committee of the Subcommittee on Demobilization of the Aircraft Industry" (also see lead story, page 221) . . . New brochure on engineering management has been published by M.E.N., describing in details these functions. Copies are available, without cost, by writing the Methods Engineering Council, 822 Wood St., Pittsburgh 21, Pa. . . . A monograph, "Organization of Technical Research in Industry", has been released for distribution, and gratis copies may be had by writing Industrial Research Institute, 60 E. 42 St., N. Y. 17, N. Y. . . . Technical Service of AIA has just completed "General Outline for Aircraft Equipment Testing", containing complete information on tests necessary to determine suitability of new equipment. Copies are available from AIA, 610 Shoreham Building, Washington 5, D. C. . . . "War Contract Terminations & Settlements" is report by Director of Contract Settlement to the Congress . . . Aeronca is distributing colorful new booklet giving details on company's new line of personal craft and containing listing of official world records made by company's planes.

Martin's giant Soviet Clipper, shipped to USSR in '38, is revealed to be still flying and to have been used for a variety of war tasks, such as carrying paratroops, dropping supplies, and carrying wounded.

★ FOR THE RECORD ★

National Skyway Freight Corp. moved from 17 East 42nd St., N. Y. C., to 147 West 46th St.

Pacific Airmotive Corp. leased entire San Jose Airport with all facilities. Earl Taylor will be company's resident representative. Located at south end of San Francisco Bay, site will be known as Pacific Airmotive Airport.

J. Gordon Lipponcott & Co., 500 Fifth Ave., N. Y. C., has been engaged to design interior styling and exterior color scheme of Republic Seabee.

Northrop Aero Institute, div. of Northrop Aircraft, will offer home study and resident courses in aero engineering and airline maintenance, beginning in first quarter of '46. Venture will be operated in specially designed buildings at Northrop Field, Hawthorne, Calif.

Aeromarket Research Associates, 1026 Shoreham Bldg., Washington, D. C., new organization headed by Paul D. Lovett, Maj. AAF (Ret.), will conduct market surveys, special reports, issue monthly market memo, and act as market consultants. Regional associates are located in N. Y. C., Chicago, Los Angeles, Seattle, Kansas City, Fort Worth, and Atlanta.

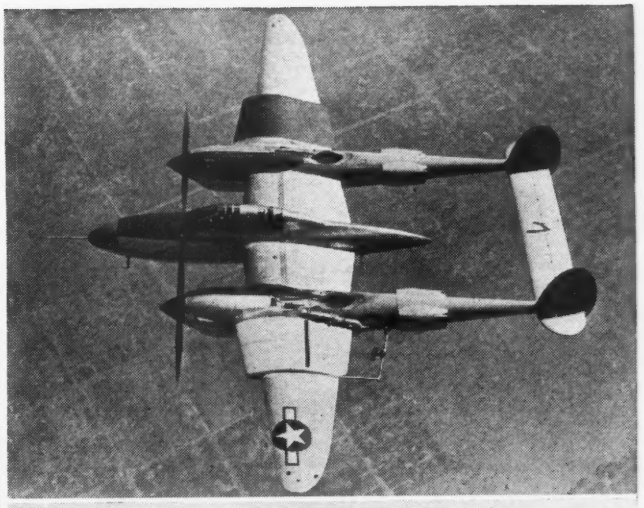
Kinner Motors changed firm name to Gladden Products Corp. Same manufacturing and sales plans will be continued and no staff changes have been made. Company is now engaged in designing a new, small, horizontal-type engine for personal craft.

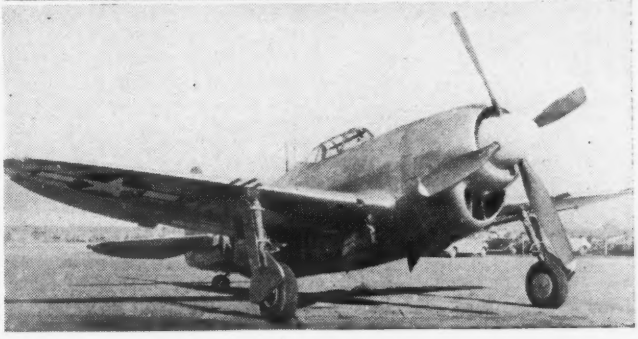
Saval Co., Los Angeles, has expanded engineering and experimental departments to care for increased volume of experimental prototype and short-run production orders of company's Hydro-Shear aircraft hydraulic and power plant controls.

Charles Dallas Reach Co., N. Y. C., received advertising account of Sperry Gyroscope Co., Great Neck, L. I., N. Y.

Hallicrafters Co., Chicago, is shaping plans to meet demands for aircraft radios. Distributors in aviation markets will be distinct from established distribution setup that had previously been functioning in amateur communications field.

Bendix Helicopter, Inc., purchased 28-acre site at Stratford, Conn., and plans to start production as soon as a factory is completed. Two other plants are to be built, one in Middle West and one on Pacific Coast.





RE-VAMPED FIGHTERS PROVE THEORIES UPSTAIRS

Top: Fitted to test drag, lift, and flow characteristics on any type of airfoil under actual flying conditions, this Lockheed P-38 modification is known as Lightning Swordfish. Name stems from 5-ft. yaw meter extending from nose. Envelopes, or false wings, that cover a portion of craft's wings, are removable sections built with contours in exact proportions to any proposed experimental wing. Static tubes are fitted to measure airfoil drag, and other tube clusters may be moved across wings in flight. Tests include diving speeds of over 525 mph.

Above: Especially designed to obtain extreme speeds from conventional power, Republic XP-47J has surpassed 500 mph. in level flight. P&W Double Wasp powered, craft has specially-designed Curtiss prop with 2-in. hand-welded trailing edge, redesigned intake ducts and engine cowling, and prop-driven cooling fan. In addition, turbosupercharger is mounted to give about 400-lb. added thrust.

Bell Aircraft received orders from Graham-Paige for over $1,000,000 worth of engines for Rototiller farm machines.

Convair is converting Nashville, Tenn., plant to manufacture of gas and electric ranges for AVCO. Later, plant will produce farm machinery for New Idea, Inc., recently purchased by AVCO.

Fairchild has contracted for production of dinghies and radio cabinets utilizing Duramold process. Negotiations are also under way for production of lightweight truck trailer bodies.

Giffels & Vallee has contract from Flint, Mich., to develop an overall airport plan for city and surrounding area. Community's present Class 3 airport is to be expanded into Class 4.

Hill & Knoulton opened southwestern regional office in Dallas, headed by W. W. "Bill" Sherrill.

Eastern Air Navigation Service, formerly located at Roosevelt Field and Great Neck, L. I., N. Y., leased fifth floor at 5 West 46th St., N. Y. C. Company purchased two Link trainers and will specialize in instrument training, ground school instruction, and pre-flight training. In addition it will handle sales and service of avigation equipment.

★ KNOW-HOWS ★

DuPont's pyroxylin flexible lacquer, applied over zinc chromate undercoat, is stated to be important factor in speed-smoothing of Ryan FR-1 Fireball fuselage.

Carboloy thread penetrator, replacing steel formerly used, is said by P & W to have greatly expedited hardness testing of small internal screw threads.

Hycar needle valve adjustment seal on carburetors of Homelite gasoline-electric generators is stated by makers to have met all operational requirements up to 30,000 ft. altitudes.

Watch-size generator, wind-driven at 100,000 rpm., is employed to provide power for VT proximity-fuse radio.

Electronic rivet sorter, developed by Glenn L. Martin, is stated to be capable of separating anodyzed rivets according to specifications.

Airline Seat Demand Rockets 25%; Route Mileage at New High; Get "Tide-Over" Planes

. . . Status of Atlantic services and notes on fares . . . UAL brief; WAL dissent . . . Chicago selects new port; Newark field reverts . . . Mail rate decision is 45¢ . . . To double ticket outlets.

U. S. domestic airlines, relieved of priorities and back on a free-enterprise basis, are now all set for the much-heralded postwar expansion period. Currently they are being swamped with a 25 percent increase in passenger-space demand, and the ATA says it will be March or April before same-day reservations can be depended upon for transcontinent trips. Coast-to-coast bookings are running three weeks ahead, short trips one week or more.

The home air system was increased 4,034 mi. in the first three-quarters of this year, bringing a new high total of 66,971. Additions authorized by CAB involved seven carriers; some were minor terminal changes. Largest single extension was on Delta Air Lines—1,224 mi. AA has been granted an addition of 653 miles.

Meanwhile the Surplus Property Administration is allocating military airplanes to the airlines to tide them over until delivery of new equipment. One recent transaction allocated 22 Douglas DC-4 type C-54's and five DC-3 type C-53s to the airlines. Three weeks later the lines received 25 C-54's and 10 C-53's. The total was 104, including four Lockheeds, and including allocations to foreign applicants and two non-carrier domestic concerns. This brings the total of two- and four-engined Douglases to 245 for domestic applicants, and 108 for foreign applicants.

Domestic airlines now serve cities comprising 33 1/3 percent of the nation's population and 76 percent of its urban population, says ATA. Certificated stops total 406, of which 315 are in use. The balance, suspended for war causes, will soon be in service. CAA estimates that existing airways pass within ten miles of some 308 cities which might be added to the network.

Pending the time when the airlines will have installed VHF airborne equipment for use with the instrument approach facilities built during the war on many civil fields, CAA is immediately erecting special equipment to facilitate instrument approaches at twelve major fields. This equipment comprises transmitters for direction finding stations, believed to be available in military surplus. Direction finding receivers are now carried in most airline planes. Installations will be at Washington, New York, Chicago, Burbank, San Francisco, Cleveland, Pittsburgh, Atlanta, Dallas, Fort Worth, St. Louis, and Kansas City.

A basic problem in relations between airlines, municipalities, and the armed forces came up recently when the Army and Navy withdrew funds which supported 20 airport control towers heavily depended upon by scheduled operators. Thirteen of the towers were continued in operation by municipalities but at a cost said to be too high for most of them to carry indefinitely. The Budget Bureau has been asked for a supplemental appropriation for the purpose, and Army and Navy are asked to resume operation in the interim.

Status of Atlantic Services And Notes on Fares

The three certificated American flag trans-Atlantic airlines are in operation and looking forward to expansion in Europe, North Africa, and the Near East. They are operating converted Douglas C-54 (DC-4 type) airplanes while awaiting delivery of new and larger equipment.

Pan American and American Overseas Airlines were already in operation at this writing, with two and three round trips per week, respectively. PAA hoped its quota would be raised to three trips by agreement between the State Department and the British government. TWA, having made an extensive survey flight through Europe and North Africa, was planning to get started around the first of this month.

PAA applied to CAB for permission to reduce immediately the trans-Atlantic fare from $525 one way to $275 one way and $495 round trip, but this was denied on the ground that this short notice would not permit competitors to take appropriate measures. The law requires 30 days between notice and effective date. The $275 rate will be in effect by the time you read this, and it was presumed other lines would have to meet it.

American Overseas merely continued its wartime rate to London of $572. TWA fares had not been announced. PAA's prewar rates were $375 one way and $675 round trip. Air Transport Command is charging $611.

Panam officials told AVIATION they feel that low fares depend strongly upon frequency of schedule. They say that with big airplanes and frequent trips they still hope to establish a one-way rate of $100 between the U. S. and Europe. Hourly departures by all three operators regarded as a future possibility.

UAL Brief; WAL Dissent

United Air Lines recently filed a brief with the U. S. Court of Appeals for the District of Columbia asking that CAB's award of the Denver-Los Angeles route to Western Air Lines be set aside and remanded to the Board for "procedure consistent with the Court's opinion." UAL reiterates its contention that public interest requires this route to be part of its transcontinent airway rather than a "stub line" operated by Western, and states that under a two-carrier operation more than 50,000 persons a year would have to make a change of planes at Denver.

The brief quotes the CAB examiner: ". . . a transcontinental operator could clearly give better service to through passengers, which will account for about 85% of anticipated traffic. . . ." UAL attacks the Board's conclusion that the two airlines will execute a passenger interchange agreement, or "even the conclusion of a probability that they will do so. There is every reason to believe that negotiations between the two competing carriers would result in disagreement."

Meanwhile, Western Air Lines has filed dissent with the recommendation of CAB examiners that WAL be certificated as far north as Edmonton, and that Alaska Airlines extend southward from Anchorage to Seattle. WAL has been operating to Alaska under an Army war contract. Company takes no exception to the recommendation that Northwest Airlines be certificated to Alaska and the Orient via Edmonton, because it estimates enough traffic to justify its own proposed service north to Alaska from Great Falls, and feels that it can offer Northwest the kind of competition required in the public interest.

Chicago Selects New Port; Newark Field Reverts

Douglas Aircraft Co.'s field northwest of Chicago is reported selected by the Windy City as transcontinent and transocean terminal. It's stated field will handle 360 plane arrivals and departures hourly after improvement at cost of $40,000,000.

Meanwhile, word comes that control of Newark, N. J., Airport is to revert back to city, with commercial flights scheduled by four airlines. AAF will retain several hangars for limited operations.

Mail Rate Decision is 45¢

A mail pay rate of 45c. per ton-mile for American, Eastern, TWA, and United Air Lines is CAB's final decision in its show cause order to the "Big Four." Last Jan. 1, CAB proposed reduction in rates from 60c. to 32c. An amendment later changed the proposal to 45c., partly in response, it is presumed, to airline reduction of passenger fares.

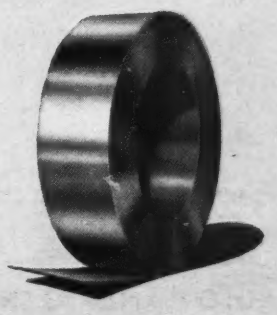
The 45c. rate is retroactive to Jan. 1. Harllee Branch, Board member, wrote a separate opinion in which he said

PLENTY OF BUSINESS FOR AA

Calling it world's largest airline passenger reservation room, AA maintains this office at LaGuardia Field, N. Y. C., where staff of 170 handles between 6,000-7,000 phone calls on an average weekday, plus 4,000 teletype messages from other cities in company's system. It is estimated that five calls must be handled for every passenger carried, and each operator averages 18 to 22 calls per hour. At left is "quote board" giving information on flight conditions and reservations available out of N. Y. C. and other cities on AA's routes.

Have you investigated the possibilities of this proved-in-service Stainless Steel for your products?

If steel is to be part of your product, consider the ability of *stainless steel* to do a better job . . . and if stainless is your choice, make *Superior Stainless Strip Steel* your first specification. • The complete range of Superior Stainless types and grades, produced by specialists to high precision standards, is discussed in detail in our new 28-page Brochure. May we send you a copy?



Superior Steel CORPORATION

Carnegie, Pennsylvania

Tag line for Today!

From now on thousands of tons of commercial freight and express will fly. Raw materials, finished goods from our factories, produce fresh from our farms, will move by air to markets of the world once impossible or impractical to reach.

Working with the airlines to make possible these vastly expanded operations are manufacturers in many fields. In the field of communications and other electronic equipment, Western Electric continues to lead the way.

Buy all the Victory Bonds you can—and keep them!

Western Electric

Distributed by Graybar Electric Company

RADIO AND OTHER ELECTRONIC EQUIPMENT FOR A WORLD ON WINGS

that when conditions permit, mail rates should be based on more precise mail carriage cost data.

To Double Ticket Outlets

Under a new plan approved by CAB, the present 573 ticket offices will be almost tripled by addition of about 1,000 travel agent outlets. By June, says ATA, there will be at least a thousand outlets. "Just around the corner" availability of tickets will help to keep airline seat capacity occupancy at a high ratio, though many new and bigger planes will go into service. Since January the airlines have been adding planes at the rate of eleven per month; the total was 88 up to September.

★ CROSS COUNTRY ★

Miniature timetable introduced by TWA is about one-half regulation size. Made up of eight pages, table carries complete data on east and westbound flights, explains fares, meal service, and also all system connections.

AA plans to acquire 50 Douglas DC-4's . . . Three-round-trip weekly service between N. Y. C. and London was inaugurated . . . Three round trips to Washington, D. C., out of N. Y. C., and additional service to Syracuse, Rochester, Buffalo, and Toronto were started . . . Present Buffalo-Toronto service is to be boosted to three round trips daily, and another round trip between N. Y. and Toronto will be added, via Syracuse, Rochester, and Buffalo.

Northeast Air Lines was authorized by CAB to consolidate routes so as to provide service from Portland, Bangor, Augusta, and points on route north of Boston, directly to N. Y. C., eliminating necessity of a stop at Boston.

PAA is raising service to Bermuda to four flights weekly, with fare reductions to $70 one-way and $126 round trip. Minimum of 160 seats weekly are available in each direction.

C-W announces that contract with EAL for CW-20 transport craft has been cancelled, stating that government policy of making surplus airliners immediately available on favorable terms makes it attractive for airlines to purchase or lease such equipment pending production of more advanced models in future.

A **comprehensive** airport facility program for Toledo area is being planned by airport div. of Giffels & Vallet, Inc. Study will cover all types of operations within a 25 mi. radius of city.

Consairway's ATC contract will be suspended next month, ending wartime airline's 3 yr. of service over Pacific. Operation was conducted by Convair. (Also see feature article on page 191.)

Braniff inaugurated airfreight at 30¢ to 40¢ per ton-mile.

CAA notes: A complete radio range and communications station has been completed at Foynes, Ireland, by CAA for that government. Station consists of a marker beacon, standard 400w. radio range, and communications equipment . . . Anticipating that 200 U. S. airliners will be operating over 170,000 mi. of world airways within 2 yr., CAA is planning immediate increase in its foreign offices from present 3 to 6, then to a total of 16 in '46.

WAL received 1944-1945 award for having best direct-mail consumer advertising in U. S. Donor is Bureau of Advertising of American Publishers Assn.

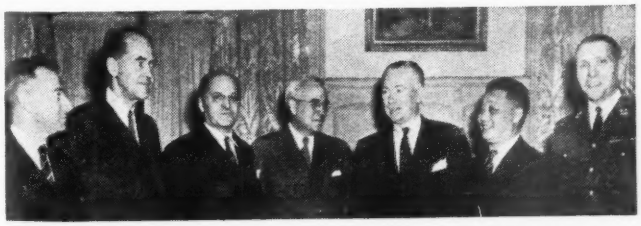
CAB temporarily amended British Overseas Airways Corp. permit, authorizing airline to conduct winter operations from Britain and Northern Ireland to Baltimore, via Lisbon, points in West Africa, Trinidad, and Bermuda.

National Skyway Freight Corp., Long Beach, Calif., Municipal Airport, flew 8,000 lb. of tulip bulbs from N. Y. C. to Southern Calif. Other recent deliveries made by airline were 16,000 lb. of table grapes from Calif. to Mo.; 10,000 lb. of garments from N. Y. C. to Chicago; a full load of furniture from Detroit, as well as airplane parts and other heavy cargo. Also carried was Philadelphia Eagles, professional football team, with 2,000 lb. of equipment in flight to Buffalo and return.

EAL put into effect a 40 percent reduction on north-bound shipments of cut flowers, cut ferns, fruits, sea food, unprocessed decorative greens and vegetables over most of airline's system.

TWA operated first commercial airliner to land in Rome, a Douglas C-54 flown from Washington.

Flight operations: NEA carried 23,507 passengers in Oct. . . . CAL flew 35,824,312 revenue passenger miles in first 9 mo. of '45, plus 77,879 ton-miles of express, and 142,645 mail ton-miles . . . Colonial Airlines flew 10,557 passengers, plus 31,910 lb. of mail and 16,745 lb. of express . . . Delta transported 28,502 passengers in Oct. . . . C & S reports 78 percent increases in revenue passenger-miles in first 10 mo. of '45 over same period of previous year.



BACKFIELDERS IN INTERNATIONAL AIR LEAGUES

Pictured at recent International Aviation Conference in Montreal are: (left to right) A. R. McComb, Australian delegate to PICAO; Dr. Edward Warner, PICAO pres.; H. J. Symington, pres. of IATA and TCA; J. C. Cooper, chairman of IATA executive committee and vice-pres. of PAA; Maj. J. Ronald McCrindle, member of IATA executive committee and BOAC deputy director general; Maj. Gen. T. H. Shen, member of IATA executive committee and vice-pres. and managing director of CNAC; and Lt. Col. J. Verhaegen, Belgian representative of PICAO.

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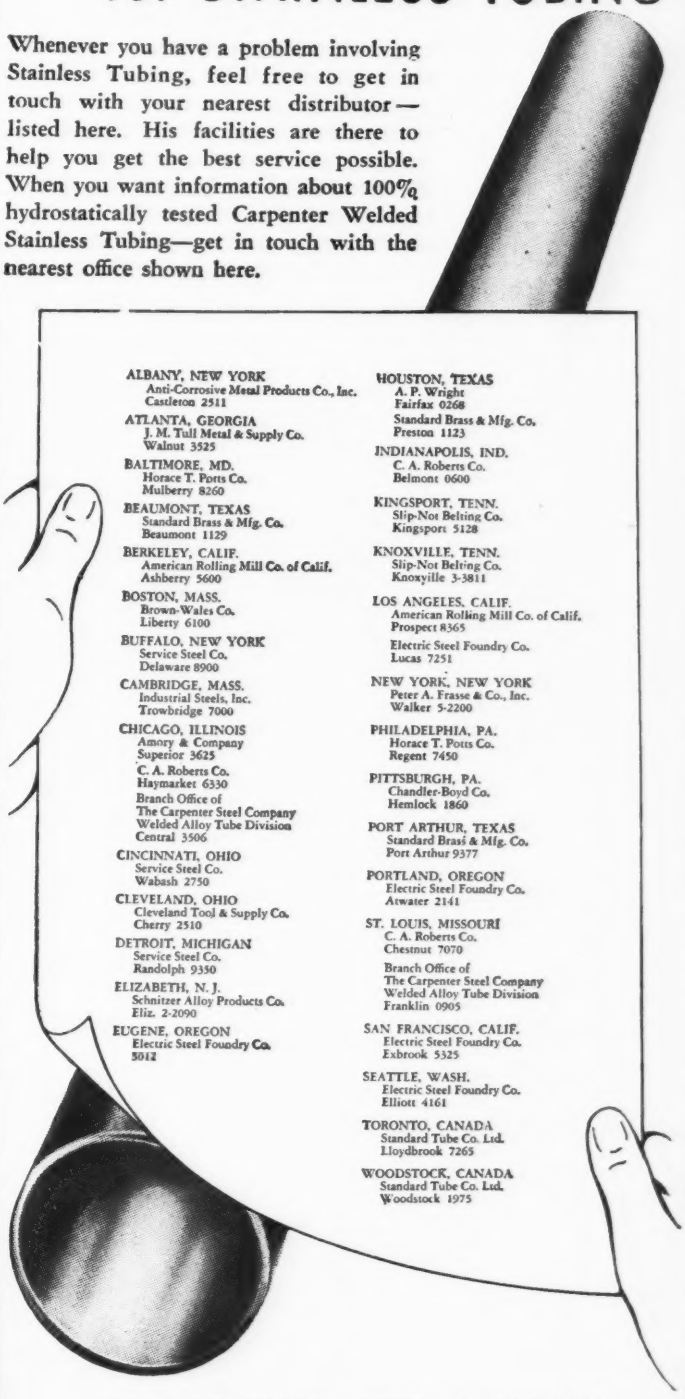

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Walnut 3525

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Standard Brass & Mfg. Co.
Beaumont 1129

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Ashberry 5600

BOSTON, MASS.
Brown-Wales Co.
Liberty 6100

BUFFALO, NEW YORK
Service Steel Co.
Delaware 8900

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Industrial Steels, Inc.
Trowbridge 7000

CHICAGO, ILLINOIS
Amory & Company
Superior 3625
C. A. Roberts Co.
Haymarket 6330
Branch Office of
The Carpenter Steel Company
Welded Alloy Tube Division
Central 3506

CINCINNATI, OHIO
Service Steel Co.
Wabash 2750

CLEVELAND, OHIO
Cleveland Tool & Supply Co.
Cherry 2510

DETROIT, MICHIGAN
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Randolph 9350

ELIZABETH, N. J.
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Eliz. 2-2090

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Electric Steel Foundry Co.
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A. P. Wright
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Kingsport 5128

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Slip-Not Belting Co.
Knoxville 3-3811

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Prospect 8565
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Lucas 7251

NEW YORK, NEW YORK
Peter A. Frasse & Co., Inc.
Walker 5-2200

PHILADELPHIA, PA.
Horace T. Potts Co.
Regent 7450

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Hemlock 1860

PORT ARTHUR, TEXAS
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INTERNATIONAL BRIEFS

ENGLAND — Many new plane models, both civil and military, have been announced by British. Among these are Airspeed Ambassador feederliner, Bristol Wayfarer (passenger version of Freighter), Bristol Buckmaster high-speed trainer, Miles Marathon medium transport, Miles Monitor target-towing craft, and Handley Page A.I.X., bomber-transport revision of Halifax.

BOAC is expected to take over operation of trans-Pacific run operated till now by RAF Transport Command. Run is from San Diego to Honolulu, then Canton Island, Fiji, Auckland, and Sydney.

Britain's press is becoming openly critical about slow deliveries of transport planes, since it appears that nothing modern will be available in any quantity till mid-1946.

Sir Arthur Tedder will be new head of RAF beginning in 1946, succeeding Lord Portal, who is retiring.

British production during war is revealed as 21,000 Spitfires, 14,000 Hurricanes, 11,391 Wellingtons, 10,000 Ansons, 9,000 Lancasters, 6,000 Halifaxes, 6,000 Mosquitos, 5,650 Beaufighters, 5,400 Blenheims, 5,000 Oxfords, 2,400 Swordfish, 1,500 Beauforts, 1,160 Battles, and 650 Fulmars.

NORWAY—This country was added to list of nations with whom U. S. has signed bi-lateral air transport agreements, thereby paving way for American Overseas Airline's route to Moscow.

SWEDEN—SILA, official Swedish international airline, has applied to U. S. for an air permit. In meantime company has obtained permission from Argentina to operate a service to Buenos Aires.

RUSSIA—I. P. Bratukhin, Russian inventor, has tested first model of his Omega helicopter, a two-passenger craft with a 112 mph topspeed. It is stated mass production will be started shortly.

Designer of YAK fighter recently exhibited new passenger planes in Moscow. Included were a luxury twin-engined plane, a single-engined limousine-type craft, and a modern pilot trainer.

INDIA—Eight new Miles planes have been ordered from England by Rusi Mistri, representative of Asian Air Associates, which is planning large scale operations in India.

IRAQ — Newly organized, Iraq State Airlines plans to operate internal airlines, and to connect Syria, Iran, and Palestine with Iraq.

IRAN—British, Russia, and U. S. have discontinued airline service into Teheran, hence only present air connection with outside world is line to Baghdad operated by Iranian State Airlines.

AUSTRALIA—Qantas has announced that Indian Ocean service to Colombo, Ceylon, will shortly be re-routed via Singapore. A daily service is expected to be inaugurated before year ends.

It has been announced that a comprehensive resort center will be set up at Alice Springs in heart of Australian Continent, with air transport to area a leading feature.

BRAZIL—A large number of surplus military aircraft from U. S. are expected shortly. They are seen giving country a top position as South American air power.

DENMARK—From Danish airline DDL went out application to U. S. for permission to operate an airline to America. Test flights are expected with converted Boeing Fortresses, while later either Yorks or Douglas DC-4s will be used.

★ CANADIAN NOTES ★

by James Montagnes

Trans-Canada Air Lines' capital has been increased by Parliament from $5,000,000 to $25,000,000 in preparation for transocean operations. Montreal to Prestwick route is already started, and by next autumn operation of a West Indies and Latin-American service is expected, as well as service to Australia and New Zealand via Russia, China, and Japan. TCA will set up subsidiary companies for services other than the domestic and routes into U. S. in order to allow other countries to buy shares in government corporation wherever required.

Reconstruction Minister Howe hints that railway company airlines are to be divorced from surface transportation control by next May.

Regional private operating companies will be allowed to operate feederlines serving TCA mainlines, and if necessary they'll be subsidized by government.

First of five Avro Lincoln bombers built by Victory Aircraft was test flown a few weeks ago. Use of these craft was not yet decided at this writing.

TCA hopes to have Douglas DC-4M aircraft in use by Sept. 1946. Craft are being built by Canadair, Ltd., Montreal. First converted DC-3 went into TCA service early in November on N. Y. C.-Toronto run.

Canadair is reconverting transports for TCA, for Eastern Air Lines, and for lines of Belgium, Portugal, France, and Norway.

War Assets Corp., as of Oct. 1, had sold 752 aircraft, of which 310 went to U. S. and South America. Canada has now sold all surplus light planes except Fairchild Cornell trainers, not yet declared surplus. Now only Cessna Crane twin-engined transports are left for sale in Canada, while many Anson twin-engine transports remain for sale outside Canada, along with a variety of combat craft.

Canadian Pacific has started daily flights from Whitehorse, Yukon, to Fairbanks, Alaska, as a subcontract for TCA, which holds international route license from CAB.

By F. H. Fullerton

RCAF planes will be used to supplement Dept. of Fisheries boat and shore patrols along B. C. coast to improve enforcement of conservation regulations and for spawning ground inspection in areas otherwise inaccessible.

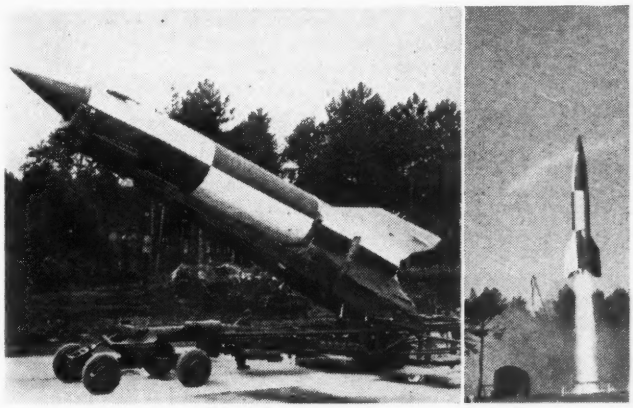
WORLDATA . . . . . By "VISTA"

Much argument has arisen in England about the continued delay of the Government in deciding on a definite site for a London airport. At the moment, airlines which operate craft like Douglas DC-3s are using Croydon, but this field is now notoriously bad and certainly not suitable for anything the size of a DC-4. Accordingly, American lines have turned to facilities quite some distance from London, waiting patiently for the time something nearer and better will be available.

During the past ten years, Croydon's suitability dropped lower and lower every time aircraft weights rose; strangely, however, the British Government has made no definite statement of policy. Considerable money was spent on Heston, then on Gatwick, but neither answered the problem. There have, of course, been many comprehensive designs for the new "national" airport within easy distance of London, but informants state that the mere thought of the large money outlay involved in such a project has obviated any specific acceptance.

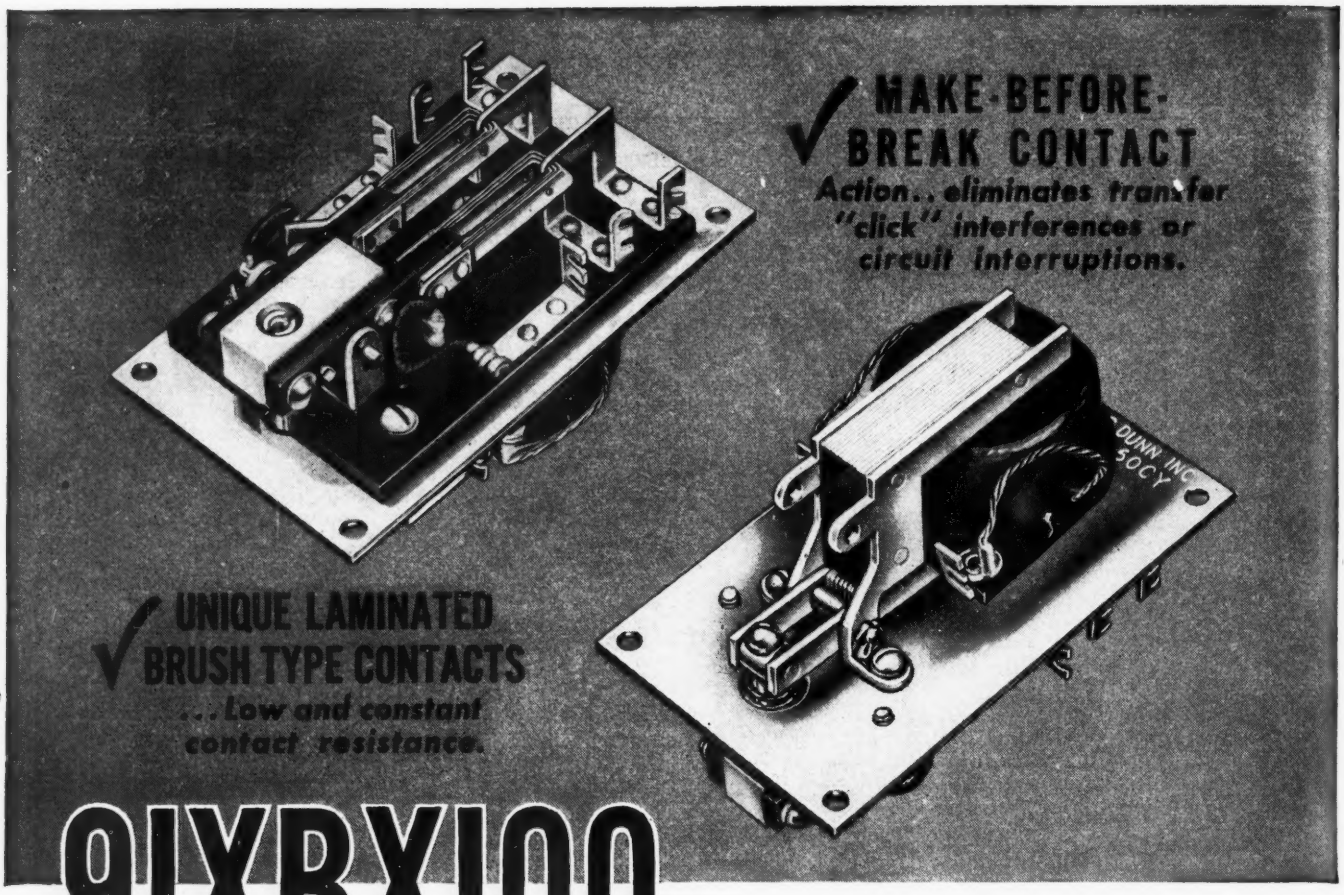
Neither is all serene on the air transportation side of the English picture. Swedish ABA was recently forced to cut three schedules per week to London off its six-day weekly service from Stockholm, thus the airline now has a waiting list miles long. It's understood that this cut in service was based on Britain's avowed "equal frequency" policy. This particular situation is closely linked with the shortage of suitable transport aircraft in England, with disorganization through lack of official policy, and with fear that without the "equal frequency" measure, nearly every other country will get a head start.

Definite steps were made known in Britain's aviation nationalization program through an announcement in Parliament that all British air transport services, all airports used by scheduled carriers, and all radio, meteorological and traffic control services will be operated by the state. BOAC is to operate a corporation covering British Commonwealth, North American, and Far Eastern routes. Another corporation will control internal and European lines, while a third will operate South American services. As expected this measure met with determined opposition. Lord Swinton vociferously condemned the plan, stating that it means indefinite delay to British civil aviation while other countries forge ahead.



TAME V-2 PUT THROUGH PACES

At Cuxhaven, Germany, British scientists are experimenting with captured V-2 rocket missiles. After assembly, warheads are filled with sand and rockets are fired at targets placed at sea about 150 mi. from aiming site. Large photo shows projectile being elevated to vertical firing position by special trailer. Two elevating arms are near rear wheels. Insert shows missile just after being fired. Checkerboard paint scheme is for obervation purposes. (British Combine photos)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5,312 RELAY TYPES

Backlogs: Bendix Aviation had current unfilled orders of $90,000,000 at last report despite heavy war contract cancellations . . . The Garrett Corp. has unfilled orders slightly in excess of $3,500,000 . . . Continental Motors Corp. recently received a $1,500,000 order from a large plane maker . . . Northrop had a backlog of $45,000,000 after war-end cancellations . . . Republic's backlog was $42,000,000 on Sept. 30 . . . Douglas Aircraft enters its new year with a military and commercial backlog of around $266,000,000 . . . Kellett Aircraft Corp. had a backlog of $700,000 on Oct. 10.

Northrop Aircraft reports net profits of $747,501 or $1.85 a share for fiscal year ended July 31, against net profits of $603,516 or $1.50 a share in preceding year. Net sales were $86,413,000 against $88,045,000.

Aviation Corp. has been ordered by CAB to divest itself of control of American Airlines by reducing its holdings of the latter's voting stock to not more than 4% of such stock. It is expected that 236,000 shares of stock will be sold within the next few months, through a group of investment bankers.

Douglas Aircraft states net income for nine months ended Aug. 31 was $16,745,000 or $8.20 a share. Sales were $642,514,000. Comparisons with previous nine months are not available. Net working capital on Aug. 31 was $64,407,000.

National Aviation Corp. reports net assets per share on Sept. 30 were $23.91 against $23.34 a share on June 30 and $18.29 a share on Sept. 30, 1944. Market value of company's investments on Sept. 30 was $10,329,000 against $6,864,000 on like 1944 date.

United Aircraft Corp. reports net profits of $9,636,000 for nine months ended Sept. 30 or $3.26 a share, against net profits of $12,573,000 or $4.37 a share in like 1944 period. For third-quarter, net profits were $2,678,380 or 89¢ a share, against $4,123,000 or $1.44 a share in like 1944 quarter. Third-quarter sales were $80,759,000 against $161,521,000 a year ago.

Fairchild Engine & Airplane Corp. states it made net profits of $258,038 for six months ended June 30 or 22¢ a common share. No comparison is available.

Republic Aviation Corp. reports net profits for quarter ended Sept. 30 of $191,600 or 19¢ a share, against net profit of $698,545 or 71¢ a share in like 1944 period. Sales were $28,948,000 against $90,904,000. For nine months, net profits were $1,313,288 or $1.33 a share against $2,506,721 or $2.55 a share. Sales were $176,839,000 against $310,671,000.

United Air Lines reports net income of $4,113,116 or $2.48 a share for nine months ended Sept. 30, against net income of $5,194,509 or $3.23 a share in like 1944 period. For third quarter, net income was $1,507,155 or 92¢ a share, against $2,269,672 or $1.43 a share. Mail revenue in the third quarter declined 15%.

Penn-Central Airlines announces its net income for nine months ended Sept. 30 was $796,618 or $1.67 a share, against net income of $359,269 or 76¢ in like 1944 period. For third quarter, net income was $385,069 or 81¢ a share, against $292,806 or 62¢ in like 1944 period. Penn-Central will not be subject to excess profits taxes in 1945.

★ CALLING NAMES ★

(*Continued from page 219*)

industrial relations; **C. E. Crowley,** personnel director; **G. L. Bryan, Jr.,** to head technical dept. of engineering div.; **H. C. Wieben,** design dept.; **C. W. Miller,** in charge of administrative dept.; **N. H. Lou,** factory mgr.; **Robert Young,** plant supt.; **W. C. Miles,** head of tool engineering and mfg.; **P. E. Tignor,** head of plant engineering dept.; **P. M. Magruder,** director of commercial sales; **R. L. Sansbury** and **W. A. Terry,** Army and Navy sales, respectively; and **J. L. Bordley,** contract administration dept.

CAA appointments: **John E. Sommers,** aircraft control officer, has been assigned to Gen. Eisenhower's staff as a civilian aviation expert; **Walter P. Plett** has been appointed administrator of Eighth Region (Alaska); and **Charles O. Cary** has been named a special asst. to CAB.

Col. Luther Harris has returned to PCA as v.-p. in charge of engineering and maintenance.

Ralph E. Middleton, Aireon v.-p., has been named general mgr. of corp.'s Burbank hydraulic div.

R. Allison Gillies, former Ryan v.-p., has joined Alvin P. Adams Associates.

Allan F. Bonnalie has been appointed director of Institute of Aero at University of Ill.

John L. Senior, Jr., joined NEA as a project engineer in engineering dept.

Mark E. Nevils, formerly director of C-W's information bureau, has been appointed director of EAL's news bureau.

Leon C. Morrier, of UAL, has been elected pres. of N. Y. C.'s Airlines Terminal, Inc. Also named are **James P. Farrell,** EAL, as v.-p.; and **W. S. Allen,** secy.-treas.

ADDING IT UP . . . . . By RAY HOADLEY

Airline Merger? Trade circles report discussions between Penn-Central and Northeast Airlines regarding the advisability of a merger, and activity in the stocks of both companies lend credence. Such a deal would give PCA entrance to the valuable New England markets. However, CAB has been known to refuse approval of such combines.

Earnings. Third quarter earnings of the aircraft companies almost without exception are lower than a year ago, although the decline is not as sharp as many expected. For the final three months of the year, operating earnings for many companies will be practically nil, while others may show a small profit as they clean up the tail end of government contracts. In several cases reserves against taxes, etc., may be thrown back into the earnings column to keep results quite substantially in the black. At any rate, the profits piled up in the first nine months will be sufficient to keep almost all companies comfortably in the black for the full year.

Exit Brewster. Directors of Brewster Aeronautical Corp. shortly are expected to ask stockholder approval to dissolve the company. Established in 1932, Brewster did over $200,000,000 in war production before its government contracts were cancelled in July, 1944. At the end of '44, current assets exceeded current liabilities by around $2,500,000. It is too early to estimate how much stockholders will get after final company dissolution.

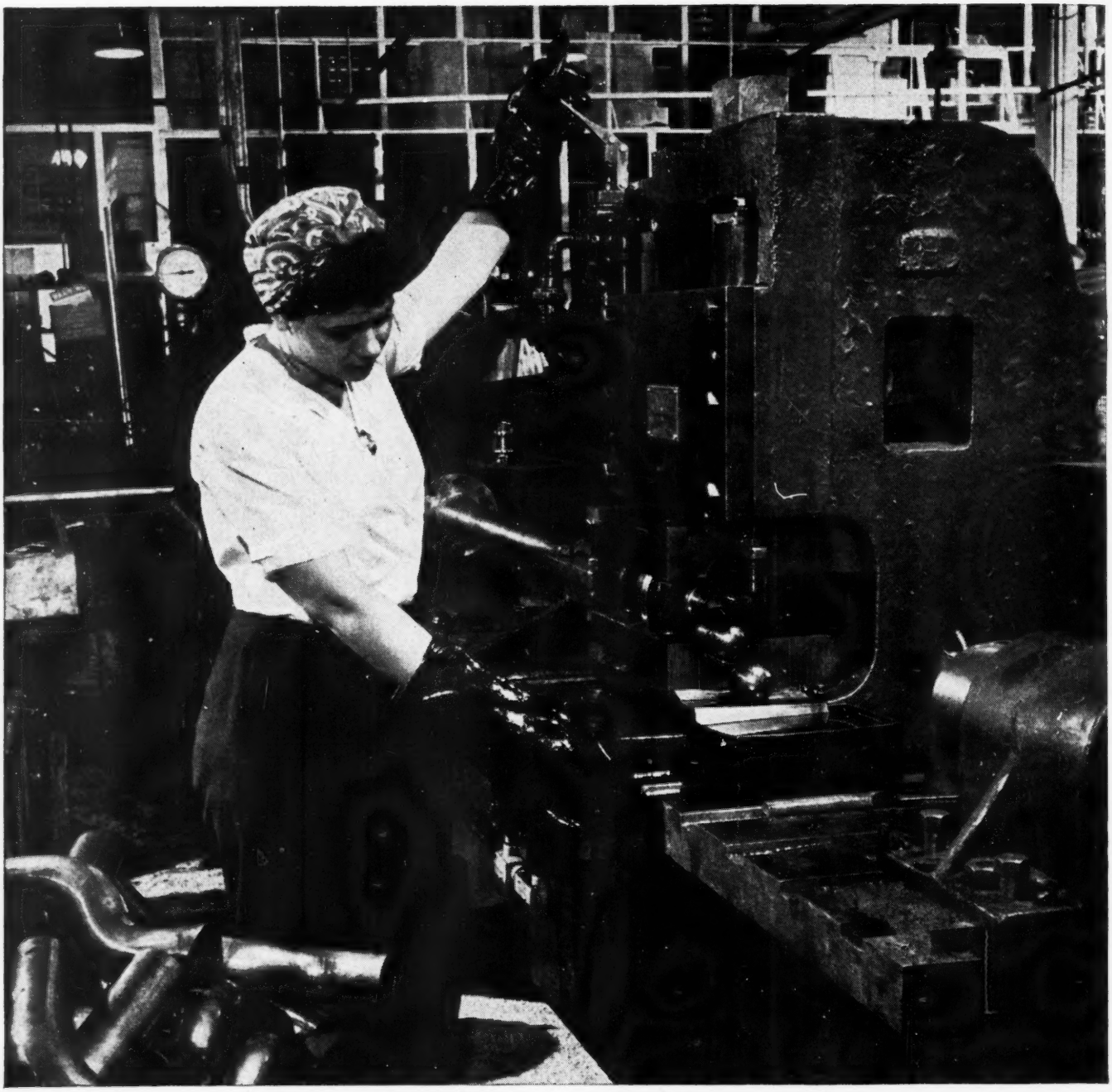
Airline Financing. Penn-Central's issue of income bonds —first in airline history—went over with a bang. Eager investors quickly bid five points premium for the $10,000,000 debentures, the first airline bonds sold since 1934. Success of the deal removed whatever qualms trade officials might have had over future financing to raise money to buy planes and equipment.

Dividends. Fifteen aircraft companies listed on the N. Y. Stock Exchange made dividend payments in the first nine months of 1945 against twelve in the like 1944 period. But the total amount paid was down 0.7%, aggregating $13,446,000 against $13,538,000 a year ago. The decline did not come as a surprise, of course; and for the entire year the decline will be much more pronounced, since the greater share of the industry's dividend declarations are in the fourth quarter. United Aircraft Corp. and Cessna reduced their payments, while Boeing omitted the regular fall dividend.

New Capital. Public financing on the part of Air Cargo Transport Corp. was launched by the sale of 300,000 common shares at $3 a share . . . Western Air Lines has registered 173,000 shares of capital stock with the SEC for sale to stockholders under warrants and to employees under a stock purchase plan. The proceeds will be used for purchase of new equipment . . . Northwest Airlines is increasing its authorized capital stock from 600,000 to 1,000,000 shares.

United Aircraft. Testimony by company officials before a Senate committee give interesting sidelights on the postwar outlook of United Aircraft Corp. Annual postwar sales are estimated at between $120,000,000 and $150,000,000. At present the company has a $130,000,000 military backlog on hand for delivery over a two-year period. These figures anticipate that postwar business will be roughly three times the prewar level of around $50,000,000 annually.

Curtiss-Wright. This company has completed nearly all of its remaining military contracts except for spares and experimental work. C-W's war order backlog of $1,850,000,000 was quickly cut back to $100,000,000. The company estimates that a minimum production of $5,550,000 a month will be needed to maintain production and research staffs. That means a heavy reliance upon future military business.



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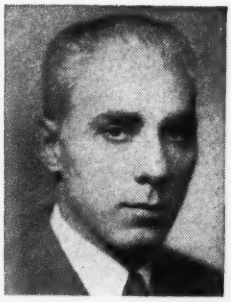
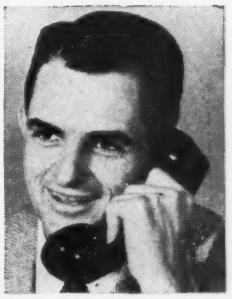


LEONARD C. MALLET has been named asst. general mgr. of P&W Aircraft div. In 1942 he was made vice-pres. of company's Missouri div. He joined Sikorsky div. in 1929, after having been with Fairchild and General Airplanes Corp., and he transferred to P&W in East Hartford in '38 as division accountant. (Bachrach photo)

COL. CARL NORCROSS, former managing editor of **AVIATION**, has joined "Fortune" magazine as aviation specialist. Holding Legion of Merit, he set up AAF's intelligence briefing and interrogation system in early days of 8th Air Force and, following VE day, worked on Strategic Bombing Survey in Europe. He attended University of Mo.

BRIG. GEN. THOMAS O. HARDIN has been elected executive vice-pres. of TACA, S. A. His duties will include supervision over airline's regional executives in charge of transportation and engineering. He was formerly on active duty with ATC. Also a veteran of World War I, he flew with 101 Aero Sq. and has 12,000 hr. to his credit.

LEONARD C. PESKIN has been elected vice-pres., contracts, for Kellett. Previously he had been products engineer and coordinator of experimental helicopter projects. He will handle military contracts, commercial sales, helicopter flight operations, and customer servicing functions of organization. He is a graduate and former instructor of MIT.



LT. COL. H. C. RANKIN has been named sales mgr. for Beech, following his release from AAF. He had been associated with company since its beginning, and served as chief pilot for several years prior to being called into military service. In '40 he won MacFadden Race flying a Beechcraft from Floyd Bennett Field, N. Y. to Miami.

WILLIAM A. BLEES has been appointed Convair vice-pres. in charge of sales, and will also serve on AVCO sales committee. Formerly vice-pres. and Pacific Coast mgr. of Young & Rubicam, he has wide experience in automotive field, in addition to his advertising work. He attended University of Mo.

LT. COL. N. HENRY JOSEPHS has been named executive asst. to pres. of C&S, with his initial duties to include special project assignments. First of these will have to do with cost control throughout airline. He resigned as special consultant to Under Secy. of War to handle this position.

GEORGE R. CUSHING has been elected to newly created position of vice-pres., operations, for Delta Air Lines. He joined company in 1935 as a pilot and has over 1,500,000 mi. to his credit. During past year he was a member of Georgia State Aviation Commission under Gov. Ellis Arnall.

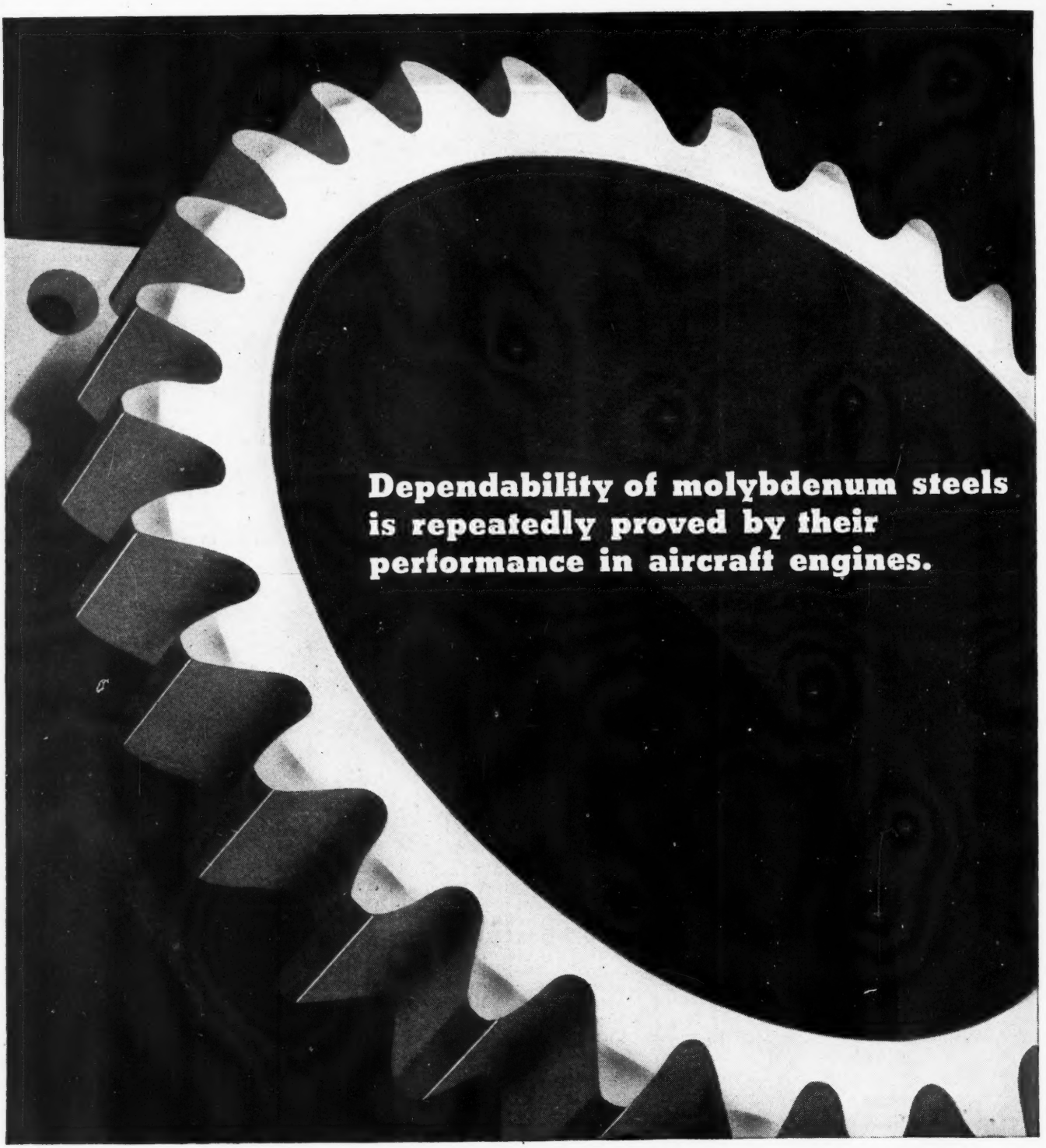
COL. ROBERT J. SMITH has returned to Braniff as a vice-pres., in charge of company's expansion and route development programs. Also a veteran of World War I, he served in ATC's air transportation div. He holds Air Medal, is a Commander of Order of Nishan Iftikar, and is an honorary pilot in French Air Force. **H. C. BROWN** (right) has been appointed director of training. For past two-and-a-half years he was supervisor of training at NAA, Dallas. After receiving his B.S. degree in education from Kansas State Teachers College, he attended University of Missouri, specializing in industrial education.

PAUL H. MERRIMAN has assumed new duties as head of electrical and electronics section of Glenn L. Martin laboratories. He is also chairman of eastern section, AWRC, a member of various NACA and NDRC committees, aircraft armor plate committee, AWS, AIEE, IRE, and IAS. Prior to his new assignment he was head of company's manufacturing development. **M. M. MAXFIELD** (right) has joined company's commercial sales group as sales engineer of new 202 transport. A graduate of Purdue, he majored in aero engineering and joined company in 1929. In 1938 he was connected with C-W's engineering dept.

JOHN C. LESLIE has been elected a system vice-pres. of PAA's trans-Atlantic operations. He was technical advisor in charge of Pres. Roosevelt's flight to Casablanca. He also served as chairman of airlines committee working on arrangements at N. Y. C. Idlewild Municipal Airport.

FRANK A. SUNDERLAND has been appointed Edo advertising and sales promotion mgr. Prior to war he had held a similar post with Taylorcraft, assisted in producing training films at Wright Field, did similar work for Lockheed, and was later with Northrop as director of visual aids.

ROBERT V. KERLEY has been named director of aero research for Ethyl. A former civilian engineer at Wright Field, and chief of oil and fuel branch, power plant laboratory of ATSC, his work has been in study and development of cooling liquids, corrosive preventives, and lubricants.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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ENGINEERING DATA

Color Engineering 1

New Concepts of Color is title of bulletin from McDougall-Butler Co., Buffalo, describing science of color engineering and its application to factories and offices. Given are technical and engineering data on use of colors.—AVIATION, Dec., '45.

X-Ray Diffraction 2

Issued by North American Philips Co., New York City, new booklet covers special problems in low angle field of X-ray diffraction including work on inorganic materials and X-ray investigation of high polymers.—AVIATION, Dec. '45.

Synthetic Molded Parts.....3

Designed as guide for engineers, *Mechanical Molded Parts of Synthetic Rubber* is picture booklet from Aero-Seal Rubber Products, Chicago, which shows how specifications are determined and which describes raw materials and manufacturing steps.—AVIATION, Dec., '45.

Ball Reciprocating Bearings.....4

Issue of *The Bearing Engineer* (Vol. 5 No. 4), distributed by Torrington Co., South Bend, Ind., contains information on use of ball reciprocating bearings, also special articles on ball thrust bearings in flying boats and on needle bearings in Cessna planes.—AVIATION, Dec., '45.

Marking Engineering 5

Points on Marking Metals and Plastics is reprint issued by Acromark Co., Elizabeth, N. J. Contained is information on various marking tools, machines, and procedures.—AVIATION, Dec., '45.

Production Planning Data.....6

Cards and data sheets, designed to simplify layout of production flow, provide scale prints representing machine models which can be placed on factory floor plan. They are offered by Plan-O-Mill Corp., Hazel Park, Mich.—AVIATION, Dec., '45.

Research Service 7

Specializing in application of powder metals and plastics to mechanical and electrical equipment, Hungerford Research Corp., Murray Hill, N. J., has issued booklet explaining its development service.—AVIATION, Dec., '45.

Cellular Rubber 8

Sponge Rubber Products Co., Shelton, Conn., offers circular No. 845-21, describing and illustrating scores of forms in which sponge rubber, bonded fiber, and other sub-density materials are manufactured.—AVIATION, Dec., '45.

Hydrides 9

Importance of hydrides from standpoint of industrial application, description of hydride process, and properties of metallic hydrides, are emphasized in booklet, *The Hydride Process and Its Products*, from Metal Hydrides, Beverly, Mass.—AVIATION, Dec., '45.

PRODUCTION

Welding Rods 10

"Phos-Trode," new shielded arc phosphor bronze weldrod, is described in data sheet from Ampco Metal, Milwaukee. Also given is data on general and physical properties and amperage table.—AVIATION, Dec., '45.

Protective Coating 11

Bulletin No. 14 issued by Paisley Products, Chicago, describes "Dipwrap" protective coating compound for use on sharp edged metal objects. Also given are specifications and information on handling of coating material.—AVIATION, Dec., '45.

Engine Bearings 12

Literature from Moraine Products Div., General Motors Corp., Dayton, Ohio, announces that "Durex-100" engine bearings, designed to operate at high unit bearing pressures, are now available for peacetime use.—AVIATION, Dec., '45.

Friction Sawing 13

Advantages and limitations of friction sawing, and explanation of this new technique for cutting and shaping ferrous materials, are contained in booklet, *Friction Sawing*, from DoAll Co., Minneapolis Div.—AVIATION, DEC., '45.

Aircraft Engine Starter.....14

Weighing but 26 lb., Type 1416 lightweight aircraft engine starter, now available for general use, is described in folder from Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.—AVIATION, Dec., '45.

Steel Tubular Rivet.....15

B. F. Goodrich Co., Akron, announces that its Rivnut tublar rivet is now available in steel.—AVIATION, Dec., '45.

Hydraulic Pumping Unit 16

Operating principles, applications, and engineering data are given on pumping unit in circular, *Sundstrand Hydraulic Pumping Unit for Both Low Pressure-Large Volume, High Pressure-Small Volume*, from Sundstrand Machine Tool Co., Rockford, Ill.—AVIATION, Dec., '45.

Thermal Control 17

Method of applying thermostatically controlled heat to machines in order to keep them in perfect alignment and adjustment at all times is described in booklet, *Thermal Control*, from Garrison Machine Works, Dayton, Ohio:—AVIATION, Dec., '45.

Hose Assemblies 18

Description, photos, and engineering data on medium pressure hose assemblies is contained in Bulletin No. 104, from Aeroquip Corp., Jackson, Mich.—AVIATION, Dec., '45.

Bonding Copper and Brass.....19

How to Cash In On the Silver Ring, booklet from Air Reduction Co., New York City, describes "Silbraz" joint, method of brazing copper tubing and brass pipe into one-piece pipe line.—AVIATION, Dec., '45.

AVIATION READERS' SERVICE

DECEMBER 1945

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NEW PRODUCTS: 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

NAME..... TITLE.....

FIRM OR AFFILIATION.....

ADDRESS.....

MACHINERY & ACCESSORIES

Gage-Inspection Instrument 20

New catalog from Trico Products Corp., Buffalo, describes "Micro-Chek," comparator type gage-inspection instrument, showing three types of anvils and layout designs incorporating the instrument.—AVIATION, Dec., '45.

Bolt and Screw Data Slide.....21

Pamphlet from Elemoto Sales Co., Teaneck, N. J., describes "AN Elemoto", slide incorporating tables of U. S. Army-Navy Aeronautical Standards to read "like a drawing." Made of plastic, it gives principle dimensions of bolts, screws, nuts, washers, lockwashers, and screw thread dimensions.—AVIATION, Dec., '45.

Cold Tank Cleaner 22

Turco Products, Los Angeles, announces that its cold tank cleaner, "Fuzee", available during war only under highest priority, is now being distributed for civilian use.—AVIATION, Dec., '45.

Material Handling 23

Booklet *Industrial Logistics*, from Elwell-Parker Electric Co., Cleveland, explains how to plan a system of materials handling by using correct type of container and assembling standardized sizes of individual containers in master load units on pallets and moving them on powered industrial trucks.—AVIATION, Dec., '45.

Chucks and Tapping Attachments...24

Description and size ranges of line of automatic drill chucks and tapping attachments is given in new circular from Wahlstrom Tool Div., American Machine & Foundry Co., Brooklyn. — AVIATION, Dec., '45.

Plug Gage 25

Bulletin No. 31 issued by Comtor Co., Waltham, Mass., describes Comtorplug principle of gaging holes to fractions of .0001 in. and sizes and capacities from ¼ in. to 8 in. dia. with extended inreaches up to 17 in.—AVIATION, Dec., '45.

Metal Spraying 26

Metallizing Co. of America, Chicago, has issued new literature describing "Mogul" Model F metallizing spray gun, giving construction features, spraying speeds, and the gas consumption.—AVIATION, Dec., '45.

Heat-Treat Furnaces 27

Describing electric furnaces for hardening, annealing, brazing, and tempering various kinds of metal and auxiliary atmosphere generating and recirculating equipment, Catalog No. 108, from C. I. Hayes, Inc., Providence, R. I., also gives furnace atmosphere control information and manometer tables.—AVIATION, Dec., '45.

Tubing Tools 28

Folder No. 347 from Imperial Brass Mfg. Co., Chicago, gives tube-working tool selector table, plus description of line of tubing tools.—AVIATION, Dec., '45.

Spiral Dividing Head 29

Model K spiral dividing head, made by Kearney & Trecker Corp., Milwaukee, is described in Catalog No. WA12. Included are working drawings and information on operation of attachment.—AVIATION, Dec., '45.

Diesel Engines 30

Publication from Caterpillar Tractor Co., Peoria, Ill., gives illustrations of single and multiple installations of diesel-electric generating sets.—AVIATION, Dec., '45.

Hydraulic Presses 31

Hydraulic Press Mfg. Co., Mt. Gilead, Ohio, has issued brochure containing story of modern hydraulics applied to presses. Company's products are described and illustrated, and press applications are shown.—AVIATION, Dec., '45.

Plate Edger 32

Machine for edging or trimming plates preparatory to welding is described in Bulletin 318 from Thomas Machine Mfg. Co., Pittsburgh, Pa.—AVIATION, Dec., '45.

Boring Chuck 33

Catalog describing new boring chuck designed to center-drill a hole, bore a hole, and then drill again without removing chuck, has been issued by DeSoto Tool Co., Detroit.—AVIATION, Dec., '45.

Wire Stripper 34

Bulletin No. 15 from Lead-All Products Co., New York City, describes Model No. 100 wire stripper for use on all types of insulated wires.—AVIATION, Dec., '45.

Mounted Point Kits 35

Line of mounted point utility kits, in various assortments, are described in circular from Abrasive Co., Philadelphia.—AVIATION, Dec., '45.

Mechanical Conveyors 36

Installations and descriptions of mechanical conveyors in aircraft plants are illustrated in Booklet No. 66 from Standard Conveyor Co., North St. Paul, Minn.—AVIATION, Dec., '45.

Units for Handling Materials.....37

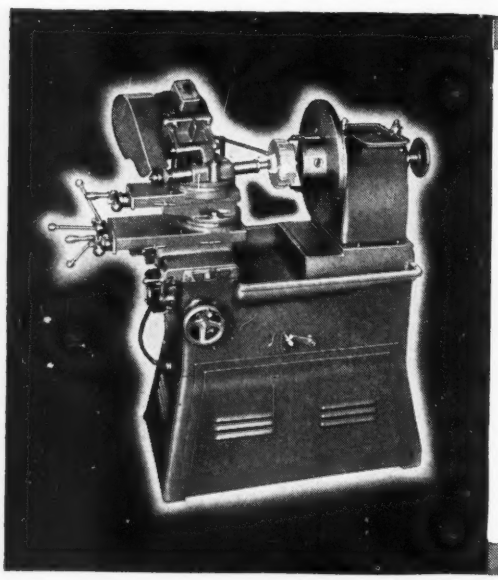
Approaching subject from executives' viewpoint, booklet from Clark Tructractor Div., Battle Creek, Mich., discusses modern mechanized materials handling. Title is *Clark Carloader Method.*—AVIATION, Dec., '45.

Radius Dresser 38

New Model 150 radius dresser, designed to make practical dressing of the tangent to a radius and the radius, too, with one set-up, is described in catalog from U. S. Tool & Mfg. Co., Dearborn, Mich.—AVIATION, Dec., '45.

Drill Machine Catalog 39

Condensed catalog of drilling and tapping machines, hydraulic drilling units, hydraulic honing machines, and coolant separators is available from Barnes Drill Co., Rockford, Ill.—AVIATION, Dec., '45.



THE
LEMPCO
MULTI-PURPOSE
GRINDER
FOR
INTERNAL • EXTERNAL
FACE & TAPER
TURNS AND GRINDS

FAST—VERSATILE—EFFICIENT

The Lempco Model ACX Multi-Purpose Grinder is a heavy-duty Universal Type machine, designed for use on the production line, as well as in the tool room. It incorporates many modern improvements to make it one of the most efficient, low-cost grinders on the market.

FAST HOLLOW-SPINDLE SET-UP

Chucks are mounted and de-mounted quickly by an ingenious draw bar that fits in the hollow work spindle. Fixtures for holding different kinds of work are rapidly and easily set-up.

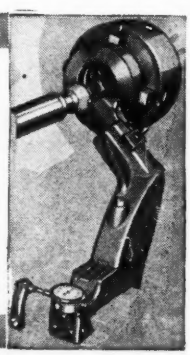
★ Adjustable Workhead
★ Rapid Changeover
★ Automatic Power Cross-Feed
★ Longitudinal Feed Controlled by Screw or Rack and Pinion

SPECIFICATIONS

Work Head Adjustment	6"
Work Spindle Speeds	80-130 RPM
Carriage Feed	.020"
Swing	30"
Face Grinding	18"
Internal Grinding, Diameters up to	18"
Internal and External Grinding, Length	8"
I. D. or O. D. Turning Maximum	18"
Face Plate Diameter	18"
Carriage Travel	16"
Cross-Slide Travel	9"
Grinder Spindle Speed, 6,000 and 12,000 RPM	

AUTO-SIZER

Automatically insures successive pieces being accurately duplicated in size, regardless of wheel re-dressings. Increases production, decreases spoilage.



WRITE FOR CATALOG

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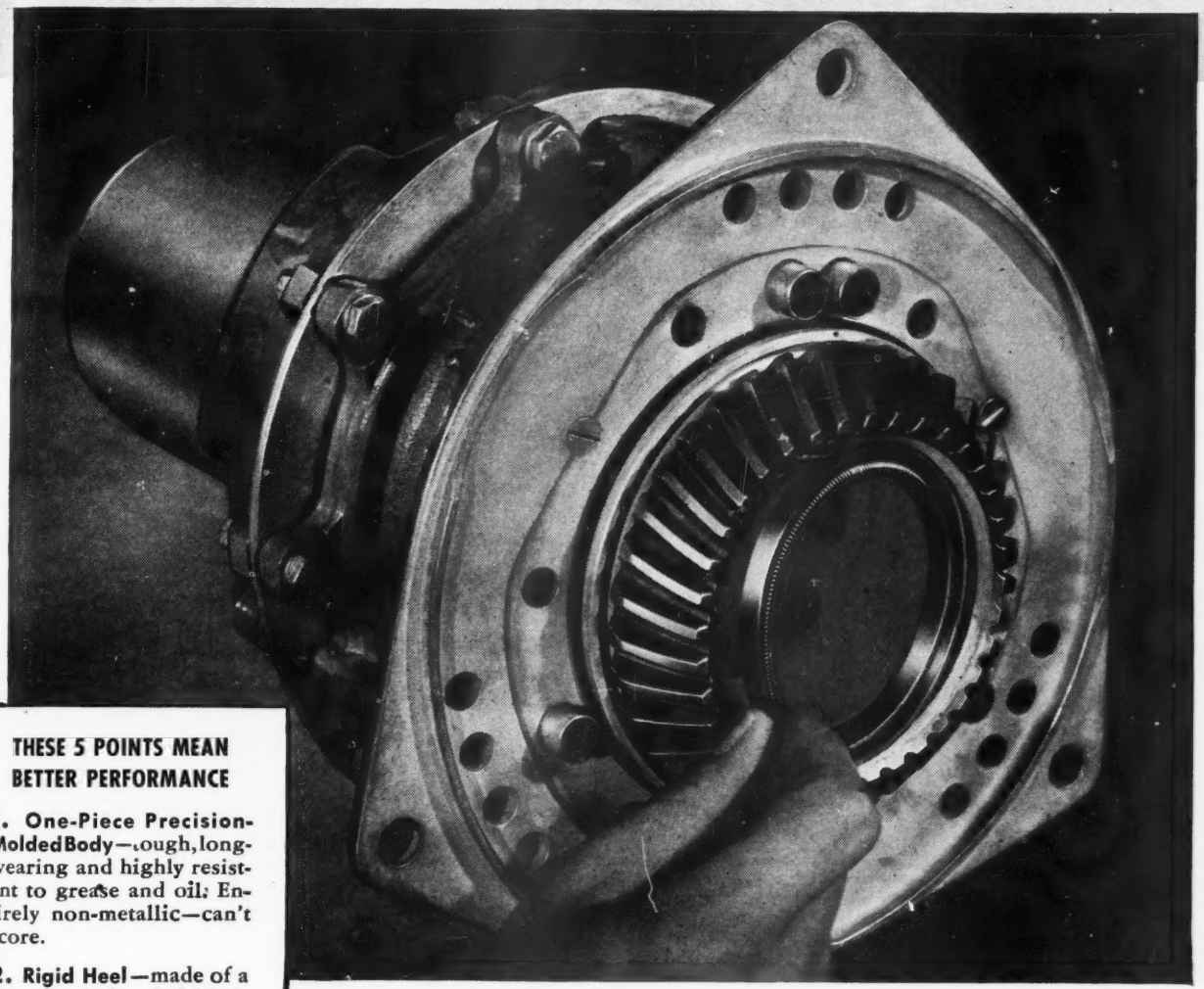
5-POINT PROTECTION
WITH J-M CLIPPER SEAL



THESE 5 POINTS MEAN BETTER PERFORMANCE

1. One-Piece Precision-Molded Body—tough, long-wearing and highly resistant to grease and oil. Entirely non-metallic—can't score.

2. Rigid Heel—made of a dense resin-bonded fabric to insure a press fit in the packing recess.

3. Flexible Lip—an integral part of the seal. Makes possible accurate control of pressure against shaft by means of self-adjusting garter spring.

4. Large Bearing Area—reduces wear on shaft to a minimum.

5. Self-Adjusting Garter Spring—permits accurate control of pressures and provides a positive contact with shaft at all times, even as wear progresses.

PROVED IN SERVICE in famous military planes produced by Curtiss-Wright and other manufacturers—the new Johns-Manville Clipper Seal simplifies design problems and reduces bearing maintenance in all types of aircraft.

Clipper Seal's unique 5-point construction means extra protection for bearings . . . longer wear for shafts, because lubrication is *sealed in* . . . dirt is *sealed out!*

Its one-piece precision-made body, concentrically molded and non-metallic, permits liberal machining tolerances. Clipper Seals are automatic in operation, easily adapted to a wide range of service conditions.

J-M Clipper Seals are made in sizes for shafts from 1 5/16 to 37" diameter, in endless and split types. Special designs may be had for extreme temperature, pressure or special lubricating conditions in either Clipper Seal or in other types of molded packings. Write Johns-Manville, 22 E. 40th St., New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Photo above shows installing a Johns-Manville Clipper Seal in the rear of a Curtiss Electric propeller power unit.

J-M PRODUCTS FOR THE AVIATION INDUSTRY

Packings and Gaskets • Friction Materials
Insulations • Asbestos Textiles • Transite Conduit
Transite Pipe • Industrial Building Materials

—Johns-Manville—

Commutator Dressers 40

Views of factories and various departments are given in progress circular from Ideal Commutator Dresser Co., Sycamore, Ill.—AVIATION, Dec., '45.

Reversible Thread Gages.....41

Bulletin No. 945, from Size Control Co., Div., American Machine & Gage Co., Chicago, announces new twin line of reversible thread gages.—AVIATION, Dec., '45.

Gear Finisher 42

Bulletin No. 860-C-45, from Michigan Tool Co., Detroit, describes improved model internal gear finishing machine.—AVIATION, Dec., '45.

Roller Chain Belts.....43

Bulletin No. 45-1, from Baldwin-Duckworth Div., Chain Belt Co., Springfield, Mass., describes roller chain belt features in detail and gives specifications.—AVIATION, Dec., '45.

Over-Running Clutch 44

"Formsprag", over-running clutch made by Gear Grinding Machine Co., Detroit, is described in folder.—AVIATION, Dec., '45.

Cutting Tools 45

Cutting and forming tools of Willey's metal are listed and described in Bulletin 28-A from Willey's Carbide Tool Co., Detroit.—AVIATION, Dec., '45.

Drill Chuck 46

In Bulletin No. 45-P, Jacobs Mfg. Co., Hartford, Conn., announces new type drill chuck in which a tough web of Neoprene synthetic rubber is stated to keep jaws in better alignment and to permit one chuck to take a wider range of drill sizes.—AVIATION, Dec., '45.

Projector Scale 47

Circular from Engineers Specialties Div., Universal Engraving & Colorplate Co., Buffalo, describes company's new all-magnification projector scale for use in optical projection method of inspection.—AVIATION, Dec., '45.

Centering Device 48

"Opti-Locator", optical device for centering and measuring on all types of machine tools, is detailed in Bulletin No. 451, from Benton Co., Los Angeles.—AVIATION, Dec., '45.

Electric Fork Truck.....49

Model MGVH electric "Palletier" materials-handling truck is described in circular from Crescent Truck Co., Lebanon, Pa.—AVIATION, Dec., '45.

Electric Soldering Iron.....50

Sound Equipment Corp., Glendale, Calif., announces that its "Kwikheat" electric soldering iron with built-in thermostatic heat control is now available nationally through supply houses.—AVIATION, Dec., '45.

STEELS & ALLOYS

Tool Steel Tubing.....51

Descriptions and information on applications and heat treating of tool steel tubing, from ⅜ in. i.d. and ⅞ in. o.d. to 6 in. i.d. and 14 in. o.d., are given in catalog issued by Bissett Steel Co., Cleveland.—AVIATION, Dec., '45.

Stainless Steels 52

Pamphlet from Jessop Steel Co., Washington, Pa., lists and describes company's stainless steels and gives properties and characteristics.—AVIATION, Dec., '45.

Hard-Facing Alloys 53

"Colmonoy" hard-facing alloys are described and their applications suggested in folder from Wall Colmonoy Corp., Detroit.—AVIATION, Dec., '45.

Beryllium Alloys 54

Information on advantages and applications of beryllium is given in leaflet from Brush Beryllium Co., Cleveland.—AVIATION, Dec., '45.

ELECTRICAL

Engine-Generator Units 55

New catalog pages from Atlas Aircraft Products Corp., New York City, describes engine-generator units for d.c. work from 175 to 500 w., 6 to 32 v., and 11 to 67 amp. maximum charging rates.—AVIATION, Dec., '45.

Thermostats and Switches 56

Descriptions and specifications of thermostats, pressure switches, and aircraft type temperature and pressure-vacuum controls are given in new catalog from United Electric Controls Co., Boston.—AVIATION, Dec., '45.

Resistors 57

Ohmite Mfg. Co., Chicago, is issuing information on new Series 84 "Riteohm" precision resistors, capable of being mounted by means of through-bolt and equipped with radial lug at each end.—AVIATION, Dec., '45.

Bushing & Bearing Tools.....58

Electric Appliance Parts Co., Cleveland, offers catalog sheets describing new Models 702-R and 703-A bushing and bearing tools. Applications and suggestions for use are given.—AVIATION, Dec., '45.

Aircraft Electric Connectors.....59

Cannon Electrical Development Co., Los Angeles, has issued detailed bulletin containing information on Type K and RK plugs, receptacles, dust caps, junction shells, and stowage receptacles for aircraft, instruments, radio, and motors.—AVIATION, Dec., '45.

PLASTICS

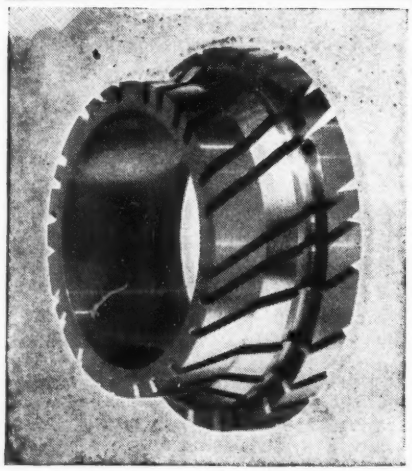
Cellulose Acetate 60

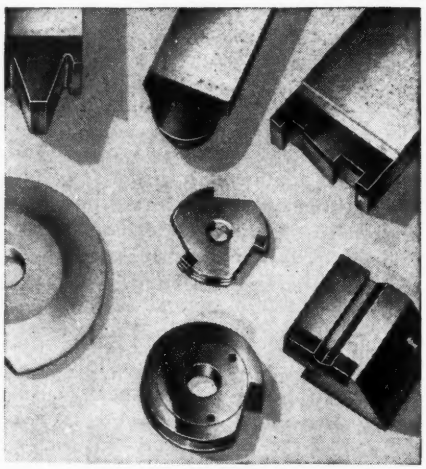
Hercules Powder Co., Wilmington, Del., has revised its technical reference booklet on properties and uses of cellulose acetate. Included is new section on use of material in laminates.—AVIATION, Dec., '45.

NOW CRUSH DRESSING OF GRINDING WHEELS ... by Perfex

THIS REVOLUTIONARY NEW METHOD of dressing grinding wheels, with its much greater accuracy and increased speed, is taking industry by storm.

Perfex is especially pleased to announce that we can now furnish you crusher rolls (both thread and form) made to your own specifications.





Typical crusher roll shown above, will dress your grinding wheel in a fraction of the time previously required and with greater accuracy.

Perfex is also prepared to offer you Carboloy or high speed steel circular, flat or dove-tail forming tools such as those shown above.

If you are not already familiar with the story of crush dressing of grinding wheels, we will be glad to answer your questions. Write us today or ask for quotations.

PERFEX GAGE & TOOL COMPANY
3609 GAYLORD AVENUE DETROIT 12, MICHIGAN

ACCURACY PERFEX OUR CREED

PLANT SERVICE

Portable Vacuum Cleaner.....61

Dimensions, capacity, power, performance, and weights of "Exidust" portable vacuum cleaners for industrial use are given in Bulletin F-4 from Allen Billmyre Co., Mamaroneck, N. Y. — AVIATION, Dec., '45.

MANAGEMENT & EMPLOYEES

Radial Power Saws.....62

How to Operate and Maintain the DeWalt Saw is new manual from DeWalt Products Corp., Lancaster, Pa., explaining radial movements of machine, typical installation layout, mechanical adjustments, and maintenance procedures.—AVIATION, Dec., '45.

Spanish-English Nomenclature 63

Technical terms applicable to tap and die industry are contained in Spanish-American dictionary from Greenfield Tap & Die Corp., Greenfield, Mass. Work is seen as contribution to standardization as well as a beneficial influence on trade. —AVIATION, Dec., '45.

Machines, Prices, and Jobs.....64

Citing examples of how modern tools contribute to high level employment, booklet, *Machines-Prices-Jobs*, from National Machine Tool Builders' Assn., Cleveland, explains historical relation between the three and pertinent economics.—AVIATION, Dec., '45.

Welding Engineering 65

Building Your Career in Arc Welding is title of booklet from Lincoln Electric Co., Cleveland, describing company's school for welders and course in welding engineering.—AVIATION, Dec., '45.

INSTRUMENTS

Radio Compass 66

Bulletin from Bendix Radio Div., Bendix Aviation Corp., Baltimore, gives description, performance specifications weights, and dimensions on automatic radio compass, MN-31 Series, covering frequency ranges from 200 to 6,000 kilocycles.—AVIATION, Dec., '45.

Gyro Transmitters and Stabilizers...67

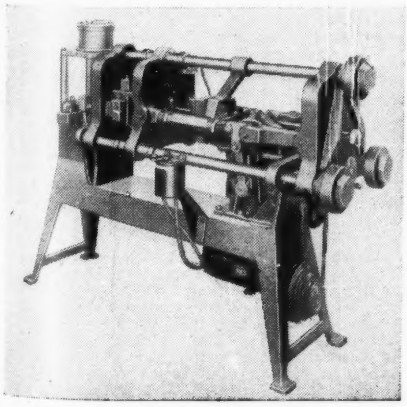
Publication 15-44, from Sperry Gyroscope Co., Div. Sperry Co., Great Neck, N. Y., describes gyro signal transmitters and stabilizing gyros. Specifications and engineering drawings are included.—AVIATION, Dec., '45.

NEW PRODUCTS

Machinery & Accessories

Die Casting Machine.....68

Stated to operate on a principle different from that of machines previously made, new die casting machine for the production of small zinc, tin, and lead alloys, is built by **Light Metal Machinery, Inc.**, Erie, Pa. Machine's casting cycle is described as automatic, with die movement, injection and ejection all actuated by one mechanism; and it has four operating speeds, 266, 400, 639, and 882 shots per hour. Speeds, predetermined by size and weight of casting being made, are reported maintained with almost no variance in continuous 24-hr. production. It operates with either air or hydraulic pressure on injection plunger. On standard model, plunger dia. is 2 in., stroke 4 in., shot capacity 18 oz., casting area 30 sq. in., and injection pressure is 1,000 psi. with air and 2,000 psi with hydraulic cylinder. Machine is 6 ft. long, 21 in. wide, 4 ft. 6 in. high, and it weighs 300 lb.—AVIATION, Dec., 45.



Horizontal Milling Machine.....69

Van Norman Tool Co., Springfield, Mass., announces new No. 2 horizontal milling machine with these engineering features: Larger column and base with internal ribbing; large dia. flywheel on inside of column; large cutter spindle mounted on Timken bearings; new spindle transmission; design for operation from either front or rear; 18 speeds and 18 feeds; and improved ram-type overarm. Table is 58 x 13 in., and drive motor is 7½ hp. Longitudinal range is 28 in., cross 10 in., and vertical 17 in.—AVIATION, Dec., '45.

Counterbore Spot Facers.....70

Set of four adjustable counterbore spot facers with wide cutting range, designated CS-1H, is announced by **Robert H. Clark Co.**, Beverly Hills, Calif. Tools cut any fractional or decimal dia. within ¼ to 1⅜ in. o.d., and each is stated easily adjustable to wide range of sizes. Holes may be counterbored to any depth. Cross-lip, or shoulder, is designed to prevent forming of burrs around edge of pilot hole. Set includes assortment of eleven extra pilots. —AVIATION, Dec., '45.

Drill Press Feed.....71

With touch control, new "steplessrange" power feed for drill presses, mill-

A famous name in Southern Skies . . . put there with SCOTCH *Masking* TAPE
BRAND

At the Latin American Division base of the Pan American Airways, Miami, Florida, the easy application and adaptability of "SCOTCH" Masking Tape make it possible to apply that famous name on the giant Clippers with the required speed and accuracy.

Insignia and decorative designs applied with "SCOTCH" Masking Tapes have sharp, clean-cut edges. In paint spraying Pan American Clippers, paper masks covering open areas etc. are securely held with "SCOTCH" Masking Tapes.

For practically any masking and protective use "SCOTCH" Masking Tapes simplify the work, go on easily, hold securely, yet come off readily without leaving a mark when the operation is completed. There is a "SCOTCH" Masking Tape for your particular requirements, whether for paint masking, holding, protecting, sealing, etc.

If you have a production or finishing problem that you suspect might be simplified by the use of "SCOTCH" Masking Tape fill in and mail the coupon below.

"SCOTCH" is the trade-mark for the adhesive tapes made by M. M. & M. CO.

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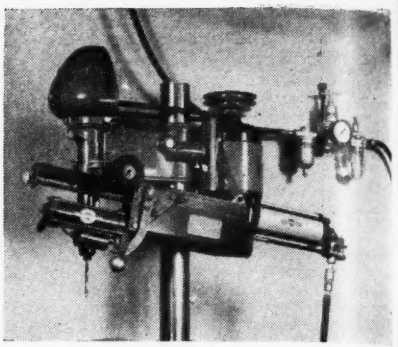


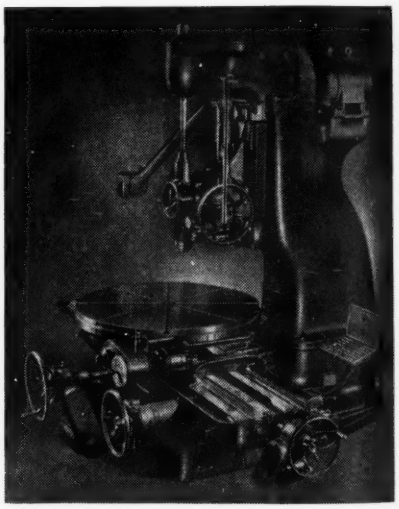
ing machines, and surface grinders is stated by maker to advance work or tools a pre-determined distance, under a pre-determined power thrust, and automatically return to starting position. New feed, made by **The Bellows Co.**, Akron, is powered by company's air motor, and it is designed to operate on any air pressure up to 160 lb.—**AVIATION, Dec., '45.**

New Hydraulic Press.....72

Cycle of operation of new automatic hydraulic press made by **Hydraulic Machinery, Inc.**, Dearborn, Mich., is as follows: Feed part (manually); press cycle-start-button; part indexes to work station; work ram moves down on work, and ejector ram moves up, unloading part in chute or conveyor; work ram and ejector ram return. Hydraulic power unit is housed in base.—**AVIATION, Dec., '45.**

Rotary Table on Jig Borer.....73

New feature on No. 3B jig borer made by **Pratt & Whitney Div., Niles-Bement-Pond Co.**, West Hartford, Conn., is large non-detachable precision rotary table built



into machine, making available equipment for precision boring to polar coordinates on large work in addition to regular rectangular coordinate work.—**AVIATION, Dec., '45.**

Shop Equipment & Materials

Roller-Coating Service 74

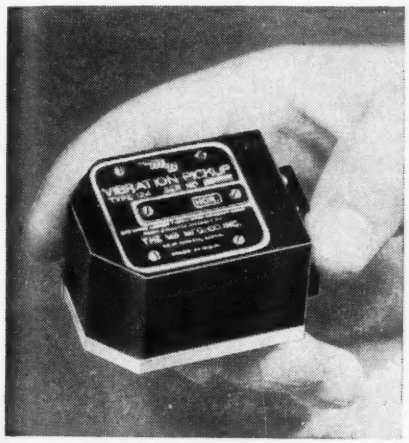
Designed to produce roller-coated sheets completely baked in 3 min. or less, new method for finishing sheets before stamping, forming, or other fabricating, is announced by **Japan Co.**, Cleveland. Various types of finishes are employed, including paint, enamel, lacquer, varnish, and plastic coatings. Coatings are applied in thicknesses to customers' specifications, and uniform color shades are stated to be maintained.—**AVIATION, Dec., '45.**

Harness Tester 75

Designed for use in smaller shops, heat-treat plants, and laboratories, Brinell testing machine of manually operated bench type, Model J, has been produced by **Steel City Testing Laboratory,** Detroit. Multi-beam and dead weight principle is employed, with weights calibrated for loads of 500 kg. to 3,000 kg. A suitable hydraulic dash pot is incorporated. Equipment furnished consists of flat anvil and "Vee" anvil, plus standard Brinell microscope with micrometer scale and case.—**AVIATION, Dec., '45.**

Vibration Pickup 76

Stated to have durability under conditions of extreme vibration, high output signal level, freedom from frictional effects limiting response at low amplitudes, and stability of calibration over wide temperature ranges, this vibration pickup was developed by **MB Mfg. Co.,** New Haven, Conn., for use in aircraft engine testing. Output is proportional to vibratory velocity, with uniform response



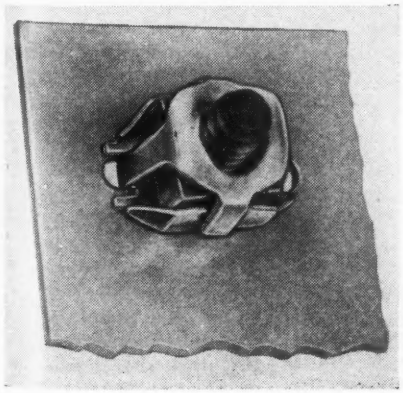
from below 10 cps. to approximately 1,000 cps., with usable response to 4 cps. Pickup is normally operated as seismic instrument, but it can be furnished with provision for direct attachment of light moving coil to structure whose vibration might be influenced by heavier mass. Pickups are furnished with flexible pigtail lead, and they are designed to be converted for use in either horizontal or vertical planes without effecting calibration.—**AVIATION, Dec., '45.**

Broaches 77

Zagar Tool Co., Cleveland, is now making broaches for company's 20 in. horizontal and 10 in. vertical broaching machines. Among those now made are 6-spline broach of 1½ in. dia. at widest point, conventional broach with key slot, and threaded-end type for use with quick-action broach holder. These broaches indicate largest hole that can be broached on 20 in. horizontal machine.—**AVIATION, Dec., '45.**

Anchor Type Locknut.....78

Designed for use on sheet-metal installations where it is convenient or necessary to have nut member held in place during assembly, new locknut made by **Kaynar Mfg. Co.,** Los Angeles, consists of three parts: Lower half is carrier for nut and is



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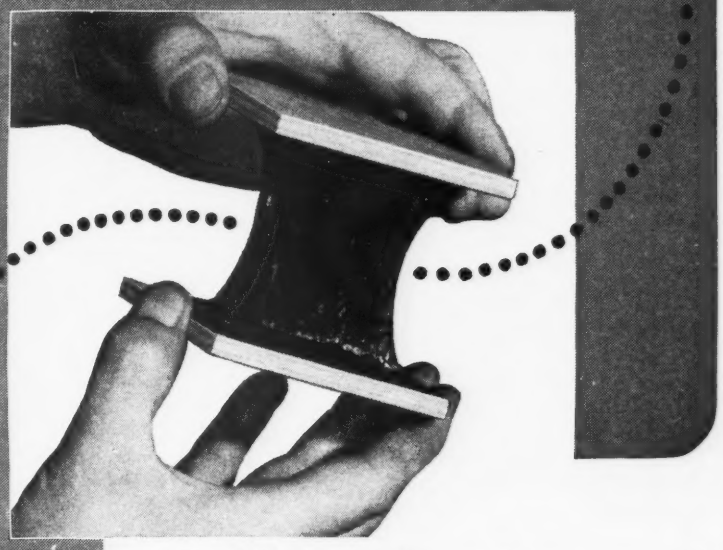

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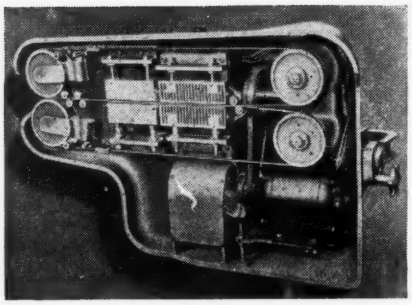
made of tempered spring steel with built-in lockwasher, while upper half, made of spring steel, keeps third part, a plain square nut, contained in assembly. Two spring ears, projecting from lower part, are used to engage sheet of metal to which nut is to be attached. To use, part to receive nut must be provided with two 5/32-in. diametrically opposed holes spaced a given distance from center hole. Locknut assembly is snapped into place by hand. Nut floats freely to allow for alignment of subsequently assembled parts. Nuts are now available in ¼ in. size, with other sizes to be ready in future.—**AVIATION, Dec., '45.**

Plastic Packaging Sealer.....79

Process for welding plastics or foil for heat-seal packaging is announced by **Sav-Way Industries,** Detroit, with introduction of new machine designed to provide air-tight and moisture proof sealing and to handle both plastic film and foil and



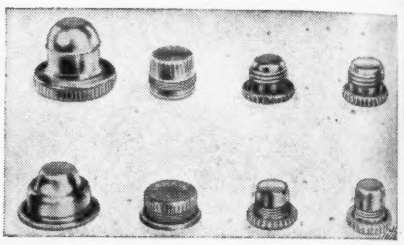
Grade C sealable paper, wax impregnated and wax coated. An electronic temperature control holds heater bars within range of 1 deg. up to 500 deg. F. Steel belts carry material to be welded between heater bars from 10 to 38 fpm. at controlled pressure and through cooling zone, in one operation. Pressure between heater bars is adjustable, and bars are self-aligning. There are wiper type oilers to wipe metal belts to prevent them from sticking. Shown here is bottom view of machine.—**AVIATION, Dec., '45.**

Carbide Gage Blocks.....80

Ranging in size from .1001 in. to 4,000 in. and manufactured in sets of 35 pieces, new gage blocks announced by **Fonda Gage Co.,** Stamford, Conn., are made from tungsten-carbide. They are stated to have exceptionally high wear resistance. Due to ultra-finish .2 to .4 micro-inch rms., wringing qualities of these gage blocks are reported to be superior.—**AVIATION, Dec., '45.**

Tubing Seal Cap.....81

Utilizing new stamping method, which was developed for precise high-speed war production, new line of protection pipe caps and plugs is made by **Tubing Seal-Cap,** Los Angeles. Threading or embossing is done by a process designed to eliminate machining or secondary operations, and it results in stamping of plugs and caps for pipe protection and other small parts with continuous threads. Now available are plugs and caps in sizes up to 1 in. fabricated from steel or aluminum. —**AVIATION, Dec., '45.**

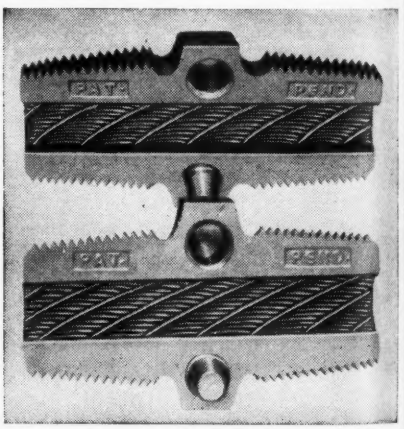


Screw Type Iron Cores.....82

Stackpole Carbon Co., St. Marys, Pa., states that its special screw type molded iron cores, now generally available, afford advantages because cores themselves are threaded. Accordingly, says maker, no brass core screw is required for adjustment.—**AVIATION, Dec., '45.**

Wire Rope Clamp.....83

"Safe-Line" wire rope clamp, developed by **National Production Co.,** Detroit, is designed to support loads of 600 lb. to 2



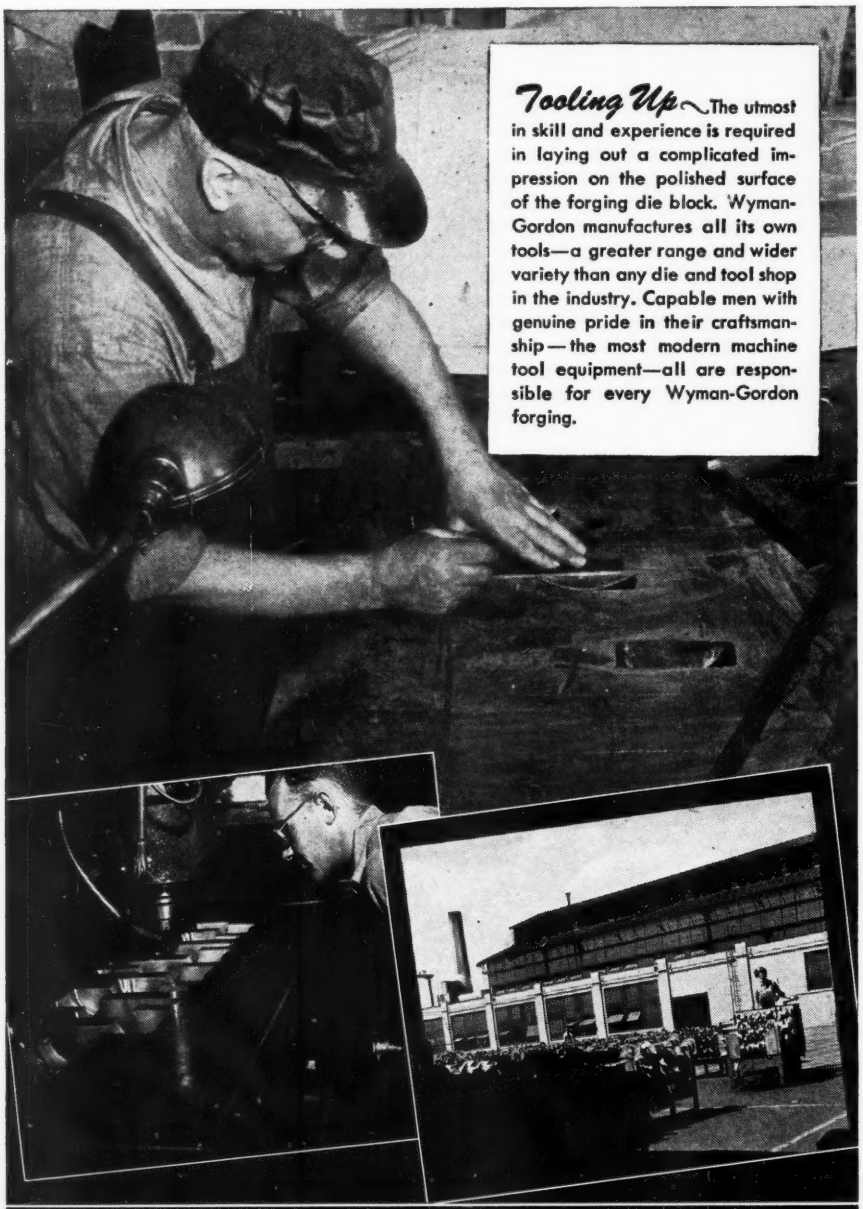
tons. It is stated to afford safety and time-saving factor inside and outside plant. Illustration, depicting open clamp, shows how double spiral splines fit each wire and strand.—**AVIATION, Dec., '45.**

Carbide Thread Plug Gages.....84

Sheffield Corp., Dayton, Ohio, announces complete range of tungsten-carbide thread plug gages, both standard and special. Quick shipment is featured, states company.—**AVIATION, Dec., '45.**

Metal Slide Rule.....85

"Deci Point" slide rule, product of **Pickett & Eckel,** Chicago, is now made of Dow metal, stated to permit superior ac-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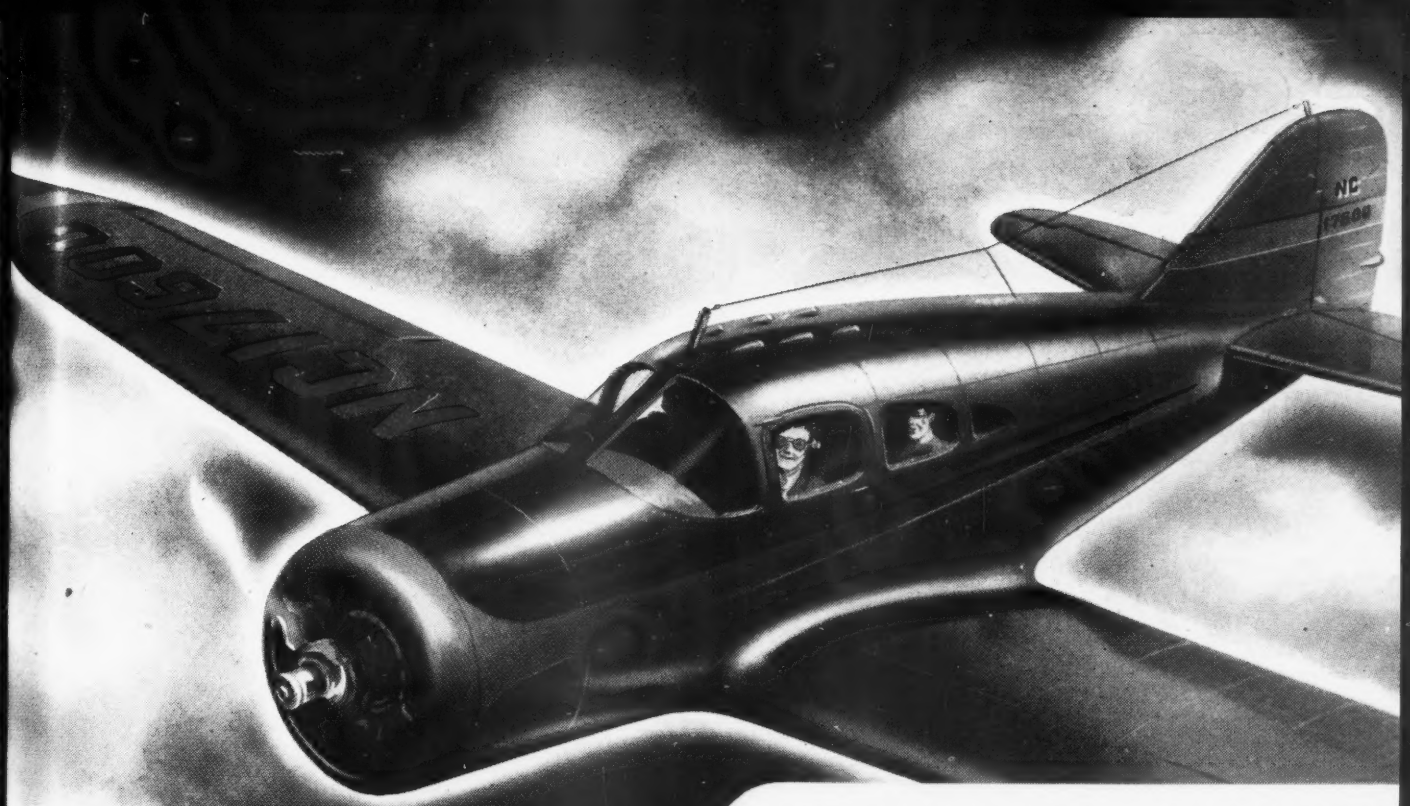

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. . . For Progress in Radio

Here are views of the just-completed Collins hangar at the Cedar Rapids Airport, and the company's 18S twin-engined Beechcraft. The installation is dedicated to constant advancement in the design and performance of radio communication and navigation equipment for aviation.

The wing to the right of the hangar contains laboratories for Collins physicists, engineers, technicians and mechanics engaged in specific projects that require much space and the use of the plane.

Customers of Collins equipment are invited to remember that these facilities are available for installation and service. The Cedar Rapids Municipal Airport, with its 5400 ft. runways, will accommodate the largest aircraft. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y. In Canada Collins equipment is sold by Collins-Fisher Limited, Montreal.

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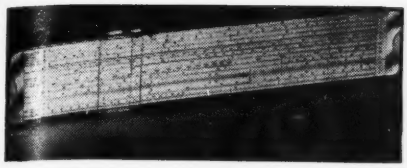


curacy since it is not affected by climatic conditions. Metal core is surfaced with flat white plastic reported impervious to water or chemicals.—**AVIATION, Dec., '45.**

Drawing Board 86

Adjustable to max. tilt angle of 60 deg. and up-and-down movement of 6 in., new

drawing board with tubular steel frame is offered by **Binkins Tool & Mfg. Co.**, Detroit.—**AVIATION, Dec., '45.**

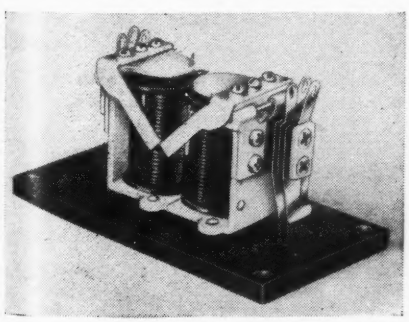
Electrical Appliances

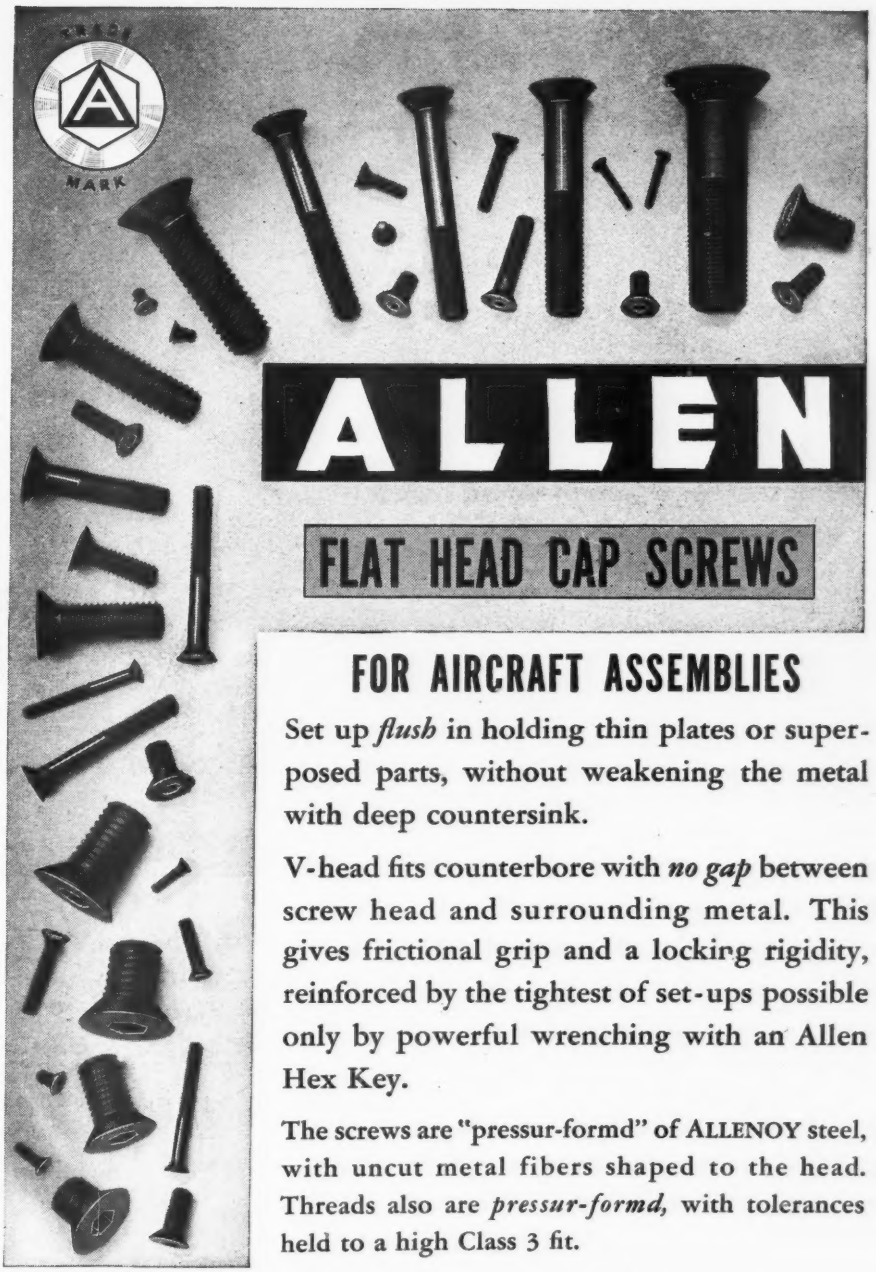
Bobbin-Type Resistors 87

For widespread use in industrial applications, new wire-bound bobbin-type resistors rated at 1, 2, and 3w. at 80 deg. C. ambient, are announced by **Sprague Electric Co.**, North Adams, Mass. Units are wound with "Koolohm" ceramic-insulated resistance wire on molded high-temperature plastic forms and are impregnated for protection against humidity. Resistance tolerance is available from plus-minus ½% to plus-minus 5%. Standard temperature coefficient wound with nickel-chromium wire is .017%. Lower coefficients can be provided. Max. permissible temperature, ambient plus rise, is 150 deg. C.—**AVIATION, Dec., '45.**

Latching Relays 88

By combining two standard "Aerotrol" 400 series relays, with interlocking armature, **Cook Electric Co.**, Chicago, has designed new latching relay. This design makes it possible to combine any two relays of similar or different types into latching relays. Company states they





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Set up *flush* in holding thin plates or superposed parts, without weakening the metal with deep countersink.

V-head fits counterbore with *no gap* between screw head and surrounding metal. This gives frictional grip and a locking rigidity, reinforced by the tightest of set-ups possible only by powerful wrenching with an Allen Hex Key.

The screws are "pressur-formd" of ALLENOY steel, with uncut metal fibers shaped to the head. Threads also are *pressur-formd,* with tolerances held to a high Class 3 fit.

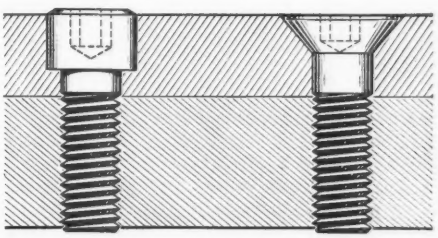

Diagram at left shows how flush surface is achieved with shallow countersink as compared with ordinary socket head cap screw. Note more binding surface under the head than is had with a fillister or cheese-head type. Angle helps lock screw in place by drawing down on a conical surface.

Your local Allen Distributor will supply you with samples to try out these signal advantages of our Flat Head Cap Screws in aircraft assemblies and shop work. Also ask for samples of Allen Socket Head Cap Screws, Hollow Set Screws, "Tru-Ground" Shoulder Screws and Dowel Pins. Complete engineering data on request to —

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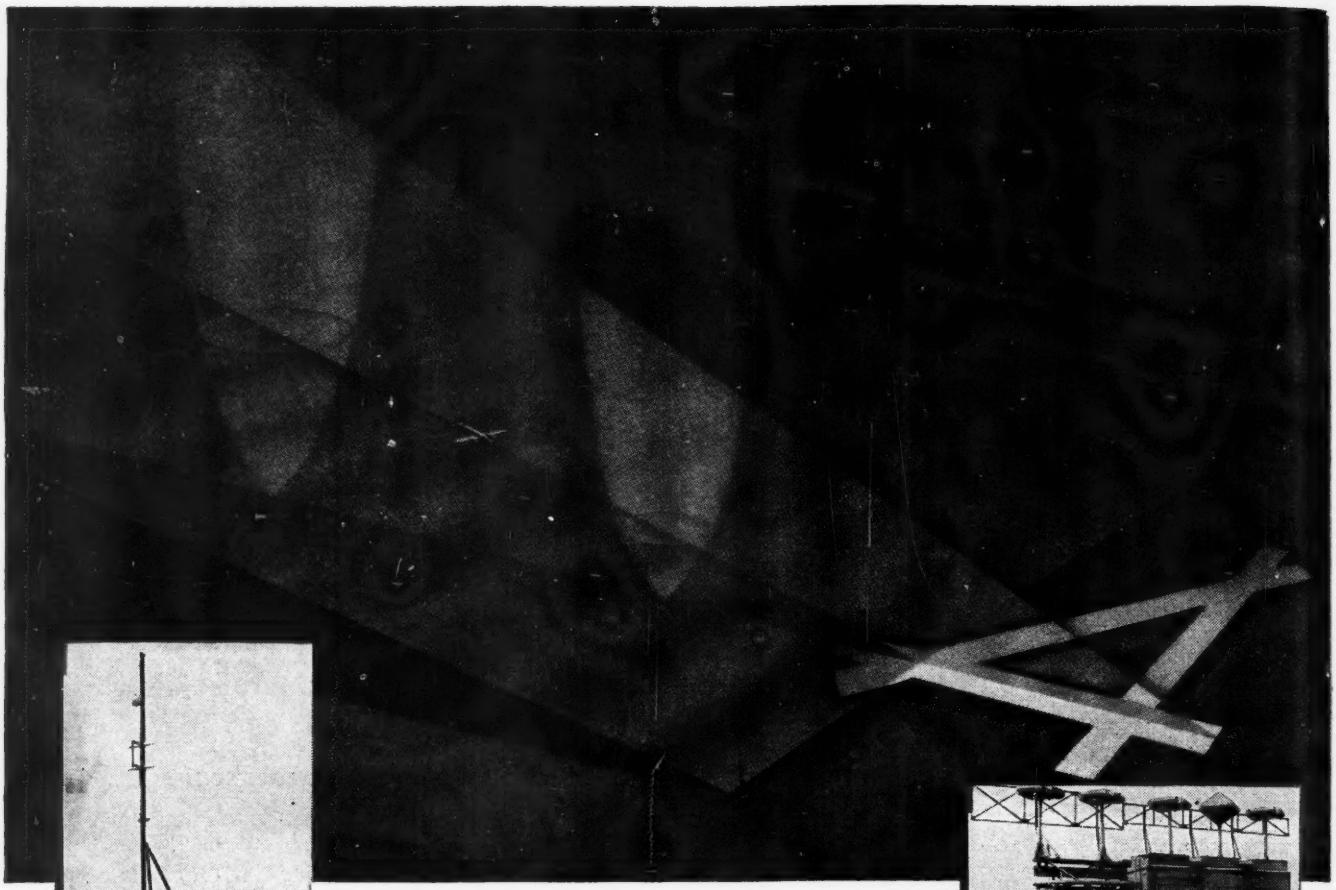

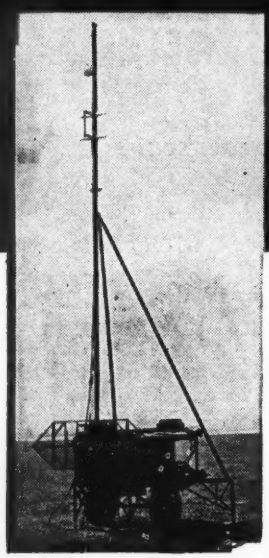

FTR Glide Path Transmitter (Air-Transportable Army Type)

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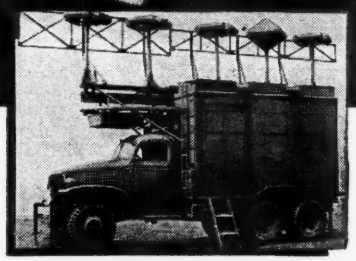

FTR Localizer Transmitter-Truck Mounted (Army Type)

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The pilot, guided by his cross-pointer indicator, flies on the intersection of two radio beams . . . one, a vertical pattern set up by the localizer transmitter which keeps the plane centered over the runway . . . the other, a horizontal pattern set up by the glide path transmitter which brings the plane to its fine-point landing.

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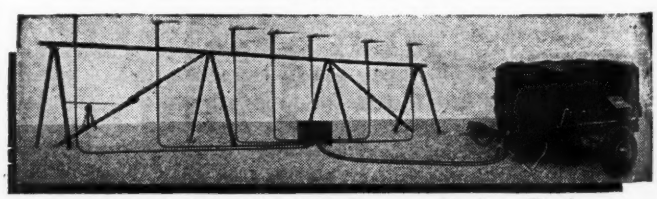

FTR Localizer Transmitter (Air-Transportable Army Type)

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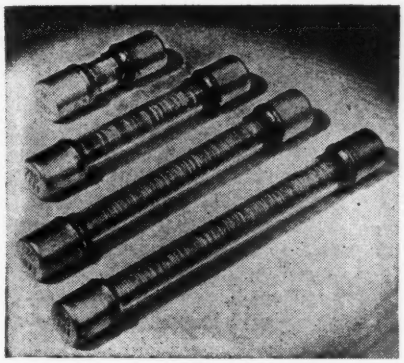
can be supplied in either single or double pile-ups and with all standard spring pile-up formations and combinations. Mounting arrangements are designed to specifications. Device can be supplied for either a.c. or d.c. operation with maximum voltage of 125 d.c. or 120v., 60 cycle, a.c. Dimensions are height 1 9/16 in., length 2⅞ in., and width 15/16 in.—AVIATION, Dec., '45.

Circuit Breaker 89

Heinemann Circuit Breaker Co., Trenton, N. J., has produced new 3-pole circuit breaker with three trip units designed to act immediately on short circuit or dangerous overload. Breakers, made in 50 amp. frame size, have true inverse time delay in hermetically sealed unit which allows passage of harmless current surges. Three trip units open simultaneously if overload or short circuit occurs in any one leg. Breaker is designed for 120/230v. a.c. or 250v. d.c., of 50 amp. max. Breaker is 5¼ in. long, 2 11/16 in. high, and 3 in. wide.—AVIATION, Dec., '45.

Selenium Rectifiers 90

Of fountain pen diameter and constructed like a cartridge fuse, new selenium rectifier stacks, hermetically sealed in glass, have been developed by Federal Telephone & Radio Corp., reports company's New York City public relations office. Electrical connection is made through silver plated ferrules at each



end, which are of a size to permit mounting in 30 amp. fuse clips polarized or unpolarized by addition of member to fuse clip assembly. Designed for operation in high ambient temperatures, rectifiers are available in several tube lengths and in various potentials up to 4,000 v.—AVIATION, Dec., '45.

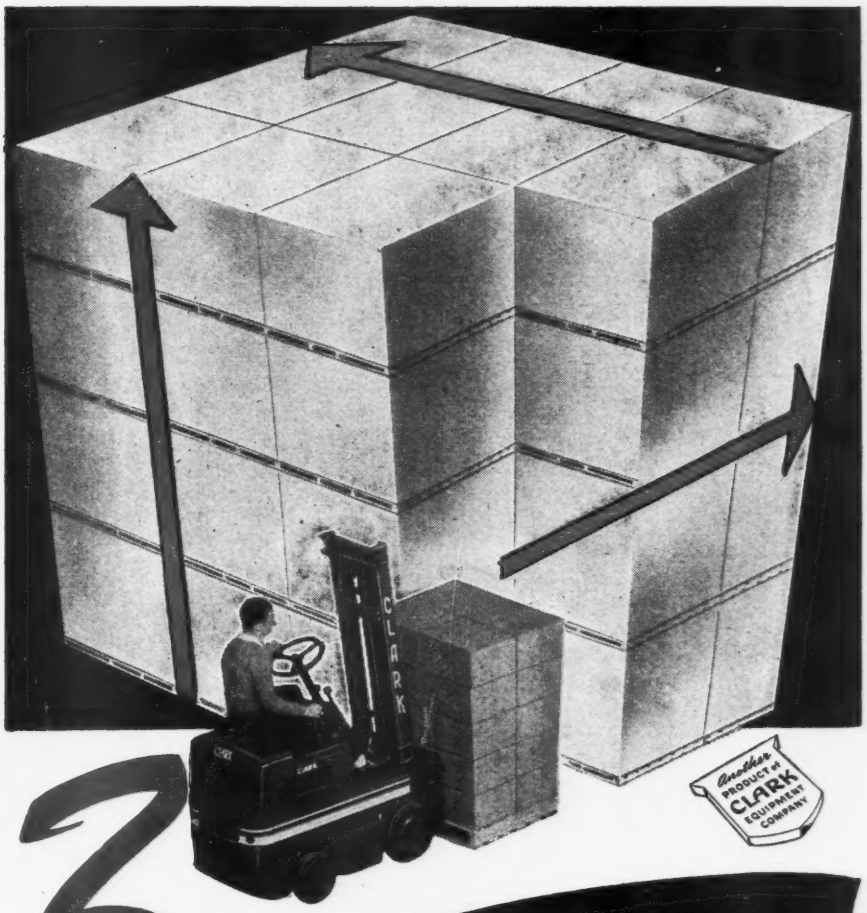
Multiple Bulkhead Connectors.....91

Stated to be adaptable to stationary wire installations where quick connection and disconnection of individual circuits from either side of panel is desirable, double-disconnect type bulkhead connector, made by Aircraft-Marine Products, Harrisburg, Pa., has permanent current carrying members extended from both sides of bulkhead. Units are of same design as knife-switch splicing terminal, permitting terminal to be connected or disconnected from multiple connector member by holding it vertically in contact with that member and pulling back. Resulting connection is four-point contact. Plastic covers snap into place to secure and insulate connections. Housing is designed to prevent accidental disengagement. Connectors are made to accommodate as many connections as desired, with different combinations of wire sizes from 22 to 10 inclusive.—AVIATION, Dec., '45.

Aircraft Parts & Field Units

"Accordion" Conveyor 92

Coming in open lengths from 60 to 100 in. with telescopic legs, accordion conveyor system is made by Food Machinery Corp., Riverside, Calif. Seen as useful for handling freight inside planes or to and from loading doors, it can be squeezed into



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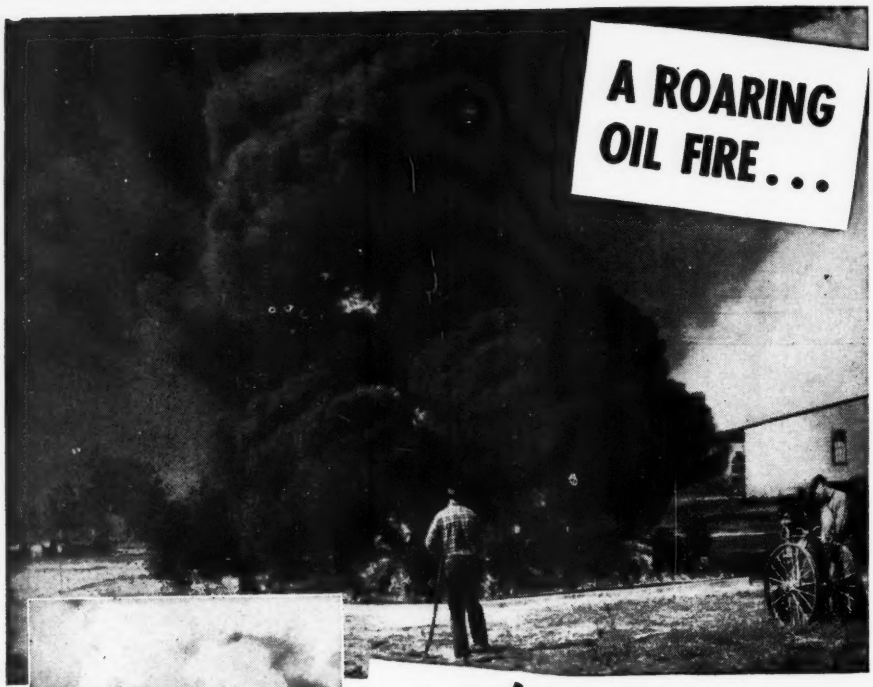

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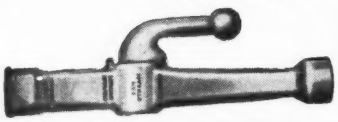
In a mere 37 seconds, the inferno was extinguished.

NEW NOZZLE STEPS UP EFFECTIVENESS



NEW DUAL-STREAM NOZZLE deals effectively with spill fires and fires difficult to reach because of height or obstructions. Designed for use with DUGAS Wheeled Extinguishers, the new Dual-Stream Nozzle greatly increases fire-fighting range and effectiveness. A turn of the handle gives a *straight* stream with a range of 45 feet—or a *fan* stream with a range of 15 feet.

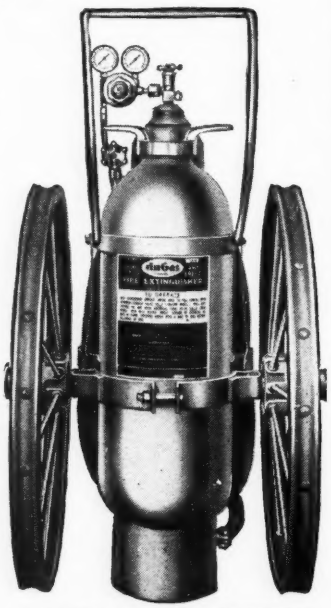
QUICK FACTS ABOUT DUGAS DRY CHEMICAL

1. For extra-hazardous fires involving flammable gases, liquids, greases or electrical equipment.
2. Not an electrical conductor.
3. Non-toxic, non-corrosive, non-abrasive.
4. Not affected by extreme cold or heat.

Write today for complete information regarding DUGAS Wheeled Extinguishers with the new Dual-Stream Nozzle... and DUGAS Hand Extinguishers.

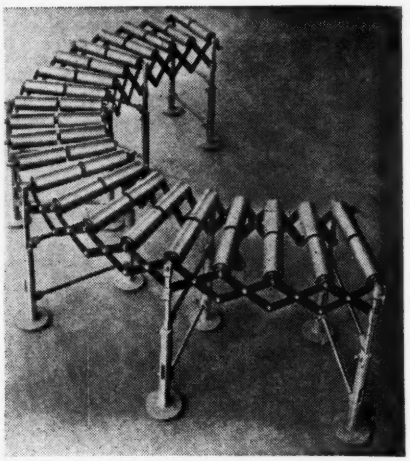
AN ANSUL PRODUCT
duGas
REG. U.S. PAT. OFF.
THE MASTER OF FLAME

Approved by Underwriters' Laboratories, Factory Mutual Laboratories



DUGAS 150-A WHEELED EXTINGUISHER

ANSUL CHEMICAL COMPANY, MARINETTE, WISCONSIN
DUGAS DIVISION



lengths of 21 to 35 in. when not in use. Split rollers made in widths from 10 to 18 in. are designed to permit S-turning of materials on conveyor without falling off and without use of siding. Each roller is built to carry loads up to 80 lb.—**AVIATION, Dec., '45.**

Personal Plane Transceiver.....93

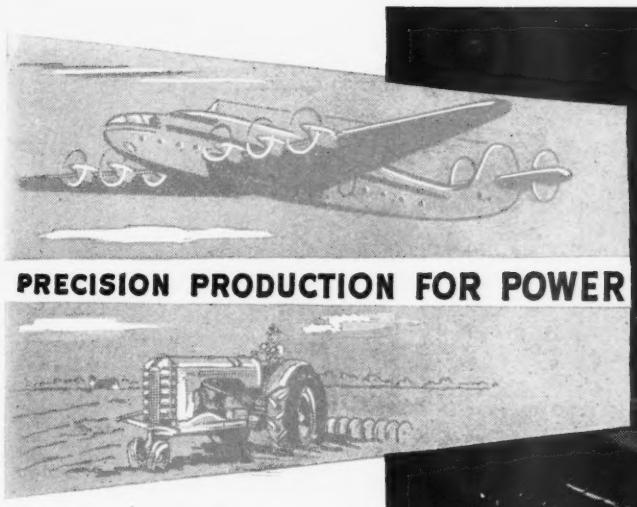
Serving as means of radio communication from plane to ground and ground to plane, and as a direction finder, Model ATR-3 transceiver made by **Harvey-Wells Electronics, Inc.,** Southbridge, Mass., is designed for use in personal planes. Weight is 12¾ lb., and measurements are 4½ in. high, 5½ in. wide, and 8 in. deep. Unit is designed to operate on 6 or 12v. synchronous vibrator power supply. Standard equipment includes tubes, crystal, headset, and push-to-talk aircraft microphone. Available equipment consists of loudspeaker, loop antenna system, and trailing antenna with reel.—**AVIATION, Dec., '45.**

Airfield Fog Dispersal 94

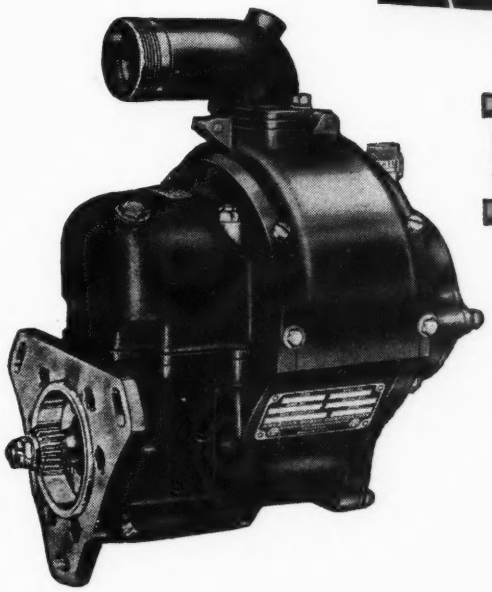
Diesel oil instead of low octane gasoline is used in new type burner for fog dispersal on airfields announced by **Babcock & Wilcox Co.,** New York City. A further development of "FIDO" (fog, intensive, dispersal, of) new system, in addition to burning cheaper fuel, is stated to represent other improvements over earlier equipment. This system, developed in this country, has burners which may be installed with a minimum of disturbance to existing airfields and a minimum of obstruction to aircraft. Instantaneous cumbustion or rapid stopping of burners is achieved by electrical ignition operated from control towers. Featured is "bushy" flame of intense heat with complete combustion. This development atomizes rather than vaporizes fuel to prepare it for combustion, utilizing an atomizing nozzle which operates with either Diesel oil or higher grades of fuel, less atomizing pressure being required as grade of fuel is improved. When Diesel oil is forced through nozzle at 1,000 to 1,500 psi., oil burns with clear flame. No preheating or vaporizing is stated to be necessary. Unlike vaporizing burners, requiring troughs or anchorages, nozzles are small steel tubes buried almost flush with ground and require only bar guards for protection. It is said that by using combinations of types of burners, very wide range of thermal capacities can be obtained.—**AVIATION, Dec., '45.**

Hydraulic Accumulator 95

Stated to be burst-proof, new hydraulic accumulator made by **Greer Hydraulics,** Brooklyn, is designed to permit neck of unit's shell to expand, letting oil leak out when internal pressure reaches 300% of rated working pressure, which is stated to be well below bursting point of shell. Accumulator cannot be dissembled until air pressure is released. It features one-piece shell of uniform thickness having no welds, joints, or seams. One-piece enclosed synthetic rubber bag has operating range between —65 deg. and 160 deg. F. Accumulator may be assembled or disassembled in field without tools. Volumetric efficiency is stated to be 97%. Large flow area is designed to eliminate restriction. A 5-in. unit for operation at 1,500 or 8,000 psi. is available, and 7½ in. and 10 in. sizes will be specially made up.—**AVIATION, Dec., '45.**



PRECISION PRODUCTION FOR POWER



Portrait of a Spark

It is important to *know* that each individual spark in the power stream that flows from an American Bosch Magneto is the right *kind* of spark for top engine performance.

Here, an American Bosch technician uses a cathode-ray oscillograph to "paint the magneto's performance portrait." From the screen he is able to determine its characteristics of current, voltage and spark length and to forecast its performance in actual use.

Making sure is inherent in Precision Production for Power. A combination of traditional craftsmanship and specialized engineering knowledge attends every production step. The resultant reliability of American Bosch products is further backed up by a world-wide maintenance organization.

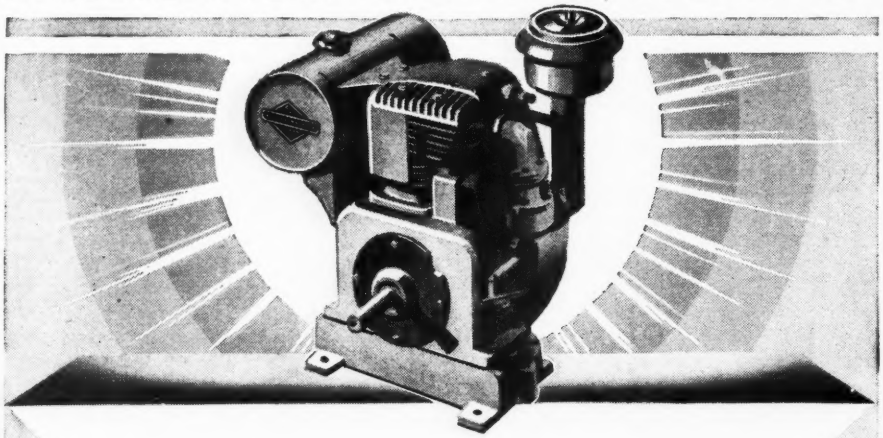
American Bosch Magnetos have served with distinction on many of our greatest warplanes and in more than 25 other military applications. *They are available today for agriculture, construction and other domestic uses.*

AMERICAN BOSCH CORPORATION
Springfield 7, Massachusetts

AMERICAN BOSCH

AUTOMOTIVE AND AVIATION ELECTRICAL PRODUCTS • FUEL INJECTION EQUIPMENT

POWER WITH
BRIGGS & STRATTON
Air-Cooled Engines
YOUR ASSURANCE OF MAXIMUM PERFORMANCE

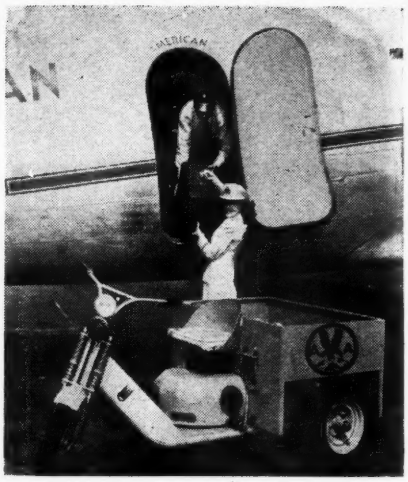


In a brilliant record of dependable and economical operation — well above 2¼ MILLION Briggs & Stratton 4-cycle gasoline engines have *earned undisputed* recognition as "preferred power" the world over. Current models are the result of skill and experience gained during more than 26 years of *continuous production* of single-cylinder Air-Cooled engines — and constant advancements in design and precision manufacture. These distinctive Briggs & Stratton advantages are your assurance of *maximum performance* — the *right power* — whether you build, sell, or use gasoline-powered appliances, machinery, or industrial equipment.

BRIGGS & STRATTON CORPORATION
Milwaukee 1, Wisconsin, U. S. A.

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

Air-Cooled Power

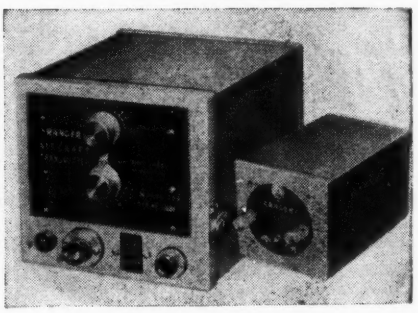


Small Delivery Truck.....96

Handling half-ton payloads of 28 cu. ft and capable of traveling 35 mph., with gas consumption of 60 mi. per gal., is three-wheel truck called Firebaugh Special. Made by **Toolcraft Mfg. Co.**, Huntington Park, Calif., unit features fluid drive.—**AVIATION, Dec., '45.**

Receiver-Transmitter 97

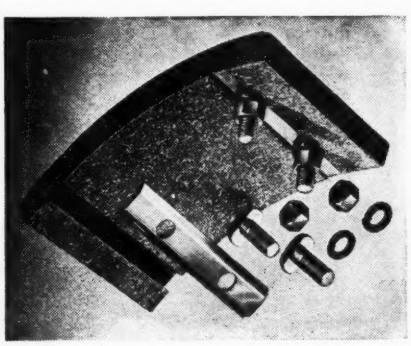
Described as providing lightplane flyer with dependable long-range, two-way communication, Model 116 receiver and Model 209 transmitter, are announced by **Ranger Aircraft Radio Div., Electronic Specialty Co.**, Los Angeles. Receiver is 5-tube superheterodyne with automatic volume control, and range filter, covering 195-410 KC band for range, weather, and



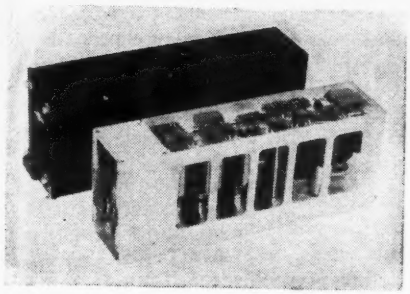
tower. It is powered by 12v. power supply in transmitter. Weight is 2 lb. 11 oz. Transmitter is single-frequency crystal-controlled unit built to provide long range contact via fixed antenna. It is stated that no pilot tuning is necessary. As regularly furnished, unit transmits on 6210 KC. Optional frequencies between 1500 KC and 14,000 KC can be supplied. Weight is 13 lb. 2 oz.—**AVIATION, Dec., '45.**

Quick Change Brake Block.....98

"Key-Lok," a new heavy duty brake block developed by **Raybestos Div., Raybestos-Manhattan**, Bridgeport, Conn., is made with lateral "fishtail" slots or keep-



ers in which bolts are inserted, spaced to fit in brake bands, keepers sliding into "fishtail" slots out into block. Keepers or shoes need not be removed for relining.—**AVIATION, Dec., '45.**



Aircraft Radio Receiver 99

Model 51K-1 aircraft communication receiver is announced by Collins Radio Co., Cedar Rapids, Iowa. Using "Autotune" for selecting channel of operation, new crystal controlled receiver offers ten preselected frequencies for reception anywhere within range of 2.4 to 18 megs. Maximum time required to change channels is stated to be 2 sec. Designed for commercial transport and for executive planes, it fits into ½ ATR unit, weighs less than 20 lb., and operates from a 24v. d.c. source. A 12v. model is optional.—AVIATION, Dec., '45.

Gascolator Bowl 100

Designed for easy draining, gascolator bowl for light aircraft is announced by Consolidair Co., Alliance, Ohio. Adaptor

extends from base to safety-type valve which is flush with outside of cowl.—AVIATION, Dec., '45.

Airline Earnings Peak

(*Continued from page* 195)

decided that mail revenue should not be included in determining whether or not an airline is subject to excess profits taxes. However, once an air transport company's earnings, other than from mail, place it in the excess profits tax range, all its income, including mail pay, is subject to the tax.

Because of tax credits carried over from previous years and other factors, all the lines except Eastern Air Lines have managed to keep out of the excess profits tax brackets. In that respect this industry, with its steadily increasing earning power has been in a class by itself.

But the time was fast approaching when most of the industry no longer could claim immunity from excess profits taxes. All that kept Delta from paying a tax on excess profits in its fiscal year ended June 30 was another unusually heavy tax charge—$500,000 for the federal capital stock tax. Penn-Central and American are right on the excess profits tax line. United and TWA probably have escaped the levy once more. However, Braniff and several of the smaller companies are close to the excess profits bracket, indeed they might have come in during 1945.

No wonder then, that Eastern's stock jumped nearly four points on the day the Senate voted to eliminate the excess profits tax on Jan. 1, 1946. Wall Street was quick to analyze the effect of the Senate action and soon had it figured out that Eastern might earn as much as $8 a share in 1946 on the basis of only the 40 percent normal and surplus tax as against $3.50 a share in 1944, a year when excess profits taxes cut heavily into net income.

Thus the elimination of excess profits taxes couldn't be better timed as far as the air transport industry is concerned. The tax will be called off just as the majority in the industry becomes subject to it. So if the industry does have sufficiently high payloads in 1946 to bring in good earnings, these earnings won't be taken away as excess profits.

Airline investors seem to have a philosophy of their own that has a highly sentimental tinge to it. They don't bother much about how high stock prices are or how much of the future has already been discounted by present prices. They know it's a colorful industry that is doing all right for itself right now. And knowing that it's one of our most promising and progressive industries, these investors are not prone to compare airline stock prices with those of, say, General Motors or U. S. Steel Corp. (*Turn to* 252)

New Keyless Chuck

does its own drill tightening

THE TURNER CHUCK Saves Time!

Hardened bearing steel roller jaws grip the drill without chewing or scoring.

Grip is automatically and progressively strengthened with increased load pressure

Ball bearings increase life.

Absolutely KEYLESS. No more chewed drill shanks. No more time wasted looking for keys.

The Turner Chuck is self-energizing. Tightens itself by the action of the drill.

Drill will not slip in use. Chuck is automatically self-centering and drill runs true without hand adjustments.

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TURNER BROTHERS

TURNER GAUGE GRINDING COMPANY

HILTON, DRAYTON & CORTEZ • FERNDALE 20, MICHIGAN

It is difficult to generalize on this industry marketwise. However, the current yardstick for measuring stock prices of airline issues appears to be a market price of around 15 times earning power. Thus Wall Street's traditional "ten times earnings" yardstick seems to have gone by the boards.

Perhaps the 1946 earnings outlook is still a bit hazy and some distance in the future. But the picture is pretty clear as far as 1945 results are concerned. The way things look now, domestic lines this year will reach an all-time record—with only two exceptions.

United Air Lines, which has enjoyed expanding earning power each year since 1941, may experience a slight drop in net this year from the 1944 showing. If so, it will be because of the mail pay reduction ordered this year. United carries an unusually high percentage of the nation's airmail.

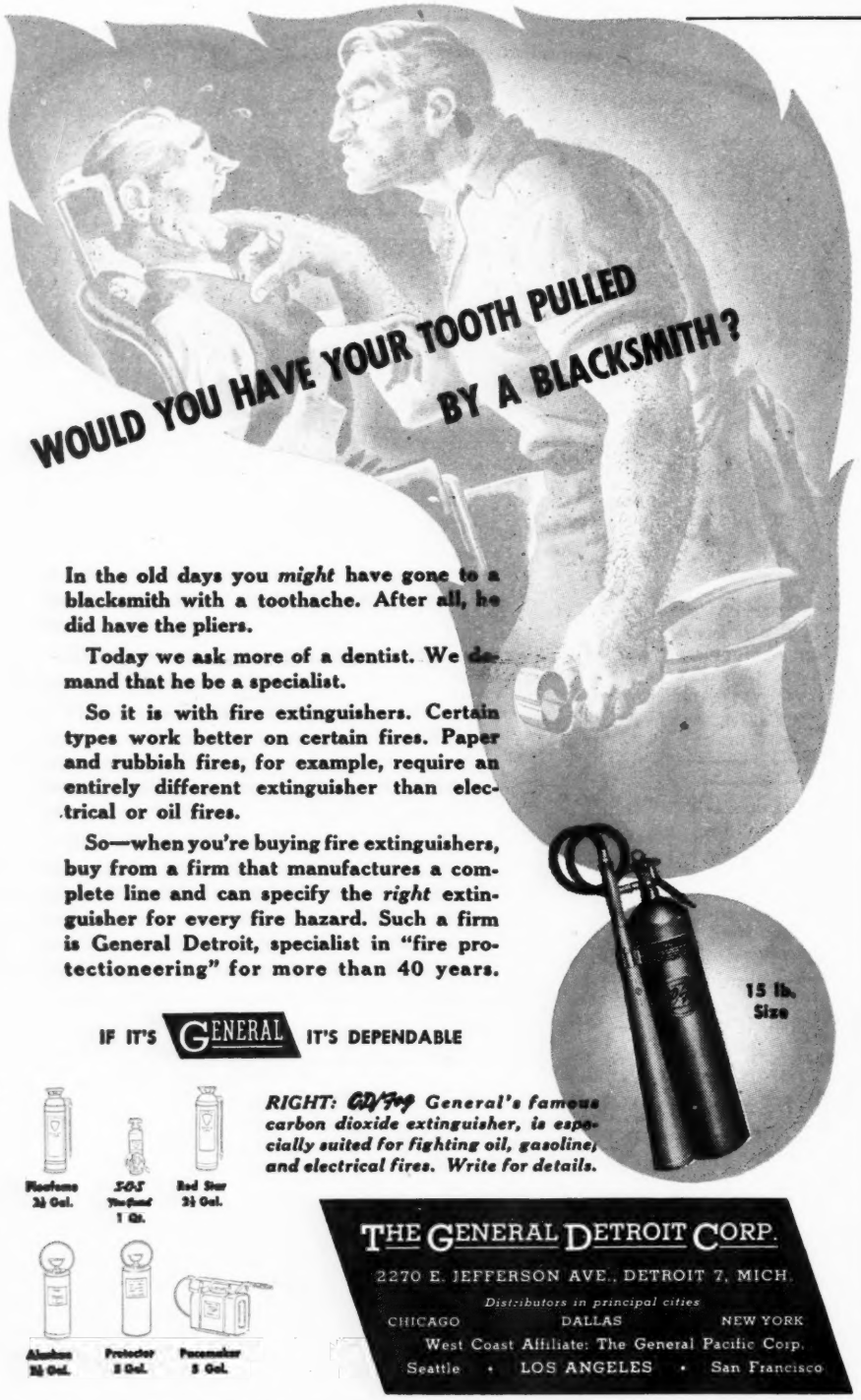
Northwest Airlines is the other exception. Here is an unusual case, since Northwest's operating picture has been heavily weighted by its large scale plane modification work, which tended to dwarf regular operations. The company is now getting the necessary transport equipment and, in the words of one observer "is just beginning to show what it can do as an airline."

Higher labor costs are a certainty next year. In fact some lines already have instituted a policy of maintaining payrolls at the 48-hr. work-week level for a 40-hr. week. Such cost increases, of course, will serve to stimulate the search for operating economies in other directions.

This year's increased earnings probably won't mean larger dividends. The airlines have succeeded during the war years in building up their working capital to a marked degree. But with ambitious equipment programs ahead of every line, they can't afford to be generous with respect to dividends in the near future. Nevertheless, the dividend picture for the industry is much more favorable today than it was five years ago.

In the last three years five airlines have initiated dividend payments, two of them—Eastern and Penn-Central—within the last year. That makes a total of nine lines that are paying dividends to their stockholders, although in almost all cases the payment is very small in relation to current earnings.

But the very fact that the industry is getting on a dividend-paying basis is a mark of growing stability of the industry. And it will prove a helpful factor in enlisting new capital to meet projected expansion needs.



In the old days you *might* have gone to a blacksmith with a toothache. After all, he did have the pliers.

Today we ask more of a dentist. We demand that he be a specialist.

So it is with fire extinguishers. Certain types work better on certain fires. Paper and rubbish fires, for example, require an entirely different extinguisher than electrical or oil fires.

So—when you're buying fire extinguishers, buy from a firm that manufactures a complete line and can specify the *right* extinguisher for every fire hazard. Such a firm is General Detroit, specialist in "fire protectioneering" for more than 40 years.

IF IT'S GENERAL IT'S DEPENDABLE

***RIGHT:** CO₂ Foy General's famous carbon dioxide extinguisher, is especially suited for fighting oil, gasoline, and electrical fires. Write for details.*

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Let a General Fire Protectioneer prescribe the *right* extinguisher for your every fire hazard.

Whipping Corrosion

(*Continued from page* 136

distributed over several feet of keel.

Because of the ruggedness of the keels, Edo-equipped seaplanes are often taxied up steep wooden ramps under their own power. Dragging the floats over concrete surfaces, however, is very injurious, and sand on wooden ramps should be avoided. The main point of damage when the plane is on the ramp is twisting of the airplane so that the keel falls into cracks between planks. The motion should always be at right angles to the planks.

Loads on the bottom section of the floats aft of the step should be avoided since the keel in that area is not reinforced for heavy weight carrying. In cases where the floats must be blocked up to insert beaching gear or for work on the bottom, the blocks should be placed under the bulkheads and not between them.

Beaching gear and equipment for handling seaplanes in and out of the water is described in Donald D. Cooke's article elsewhere in this issue (page 178).

While the detailed description of precautionary measures and maintenance required to insure airworthiness of an airplane on floats may seem to involve complicated procedures which

would hamper the convenience and utility of seaplane flying, it will be seen in retrospect that the major effort is involved before the airplane is launched and that once the plane is in use only routine procedures are needed to maintain a corrosion-free airplane.

The procedures and materials recommended represent the fruits of over 20 yr. of technological development in the float field by Edo Aircraft Corp., and they add up in sum total to removal of nearly all of the maintenance drawbacks which plagued float flying for so many years.

Convair's Consairway

(*Continued from page* 194)

(A) will make 7 x .16 = $1.12 in the same time that (B) makes 6 x .18 = $1.08. In other words, airplane (A) has shown a higher investment *rate* of return even though airplane (B) operates at lower cost per ton-mile. Thus, commercial airplanes should be compared on the basis of maximum investment rate of return to the airline operator rather than on the basis of minimum direct flying cost.

Now if the revenue rate is changed from 30¢ per ton-mile to 20¢, the above example shows an entirely different picture: (A) will now only make 7 x .06 = $.42 in the same time that (B) makes 6 x .08 = $.48. In this case (B) shows the higher rate of return. This example should clearly show the far-reaching effect that rates have on the optimum choice of design factors to give a maximum rate of return.

This same type of analysis may also be used to pick an optimum wing-loading. But in this case, when wing-loading is the fundamental variable, the maximum power-loading required to meet the minimum CAA climb requirements must be decreased as wing-loading is increased. Analysis shows that in this case also factors X, V_s, and L vary in such a way that when X is a minimum Z' is a maximum.

This type of analysis may also be applied from an operation standpoint to determine the optimum power schedule to be used for long-range flying, i.e., to determine the operating technique which will give the highest investment rate of return. As in the case where power-loading is the independent variable, the optimum cruising technique will not necessarily be determined when the direct flying cost X is a minimum (nor at maximum-range speeds); it is determined by operating in accordance with that power schedule which will show the investment rate of return equal to a maximum.

Cost studies at Convair, based upon

Scott
TAIL WHEEL ASSEMBLY
STEERABLE — FULL SWIVEL
MODEL 3-24B
Builders of light airplanes seeking a service-tested tail wheel assembly will be interested in these features of the CAA-approved Scott Model 3-24B. Simplified, automatic mechanism: Needle swivel bearings: Heavy-duty bracket: Positive action arm assembly: Drop forged single arm fork: High-strength aluminum alloy wheel castings: Timken grease-packed roller bearings: Felt grease seals: Tight dust caps. Complete data on request.
AUTOMATIC
SPECIFY AS
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Packard high-altitude ignition cable's tough synthetic rubber sheath, over an inner reinforcing glass-yarn braid, provides effective protection against extreme cold, heat, oil, moisture and electrical corona. This ability to triumph over stratospheric flying conditions makes it an outstanding cable for any altitude, in any part of the world. It is the result of years of constant research and development ... just one of many types of Packard cable serving America's air forces and aircraft industry. Whatever the need—you're RIGHT with Packard cable.

Packard

REG. U.S. PAT. OFF.

Packard Electric Division, General Motors Corporation, Warren, Ohio

BUY VICTORY BONDS AND KEEP THEM

Consairway experience, have shown that for long-range operation the old CAA regulations will limit the current trend toward increase in wing-loading long before an optimum economic value is reached. But for short-range feeder-line operation, where airport length is definitely a factor, analysis shows that optimum combination of wing-loading and required power-loading will occur at a wing-loading near the maximum allowed by the old CAA landing-speed regulations.

Our Consairway experience also confirmed many additional advantages of high wing-loading. For instance, the cruising speed for maximum investment rate of return to the operator increases directly as the square-root of the wing-loading. This is most important for long-range operation, although not of major importance for short flights. In addition, high wing-loading has resulted in a marked improvement in passenger comfort, because the gust-accelerations felt at any cruising speed decreases with increase in wing-loading.

In conclusion, these points may be emphasized:

1. Commercial airplanes should be compared on the basis of maximum investment rate of return to the airline operator rather than on the basis of minimum direct flying cost.

2. It is important that CAB establish postwar Civil Air Regulations as quickly as possible.

3. It is also very important that CAB help to establish and approve postwar revenue charges as soon as practicable because these charges will definitely affect the optimum choice of design factors to give a maximum investment rate of return to the airline operator.

4. Consairway's record of over-water operation of landplanes has proven quite conclusively that landing speeds considerably in excess of 80 mph. are safe, especially when the tricycle landing gear is used, and when airport runways are long enough. Also, experience has shown that operation economy and comfort are increased by use of higher wing-loading. Thus, it is hoped that the new CAB regulations will reflect the recent operational experience and proven safety records.

Those Airplane "Eyes"

(*Continued from page* 133)

faces with a radius curvature greater than 36 in. should be treated, because machine sanding tends to flatten curved surfaces of small radii, creating excessive optical distortion and thinning.

An alternative for sanding is ashing, which involves the use of a thick abras-

NORTON ABRASIVES

Memo to all users of Set-up Wheels

Here's why so many plants have cast out set-up wheels for

METALITE BELTS IDLER-BACKSTANDS

they gained all these advantages:

√ Factory controlled, uniformly sharp cutting surface
√ Choice of 17 grit sizes (24-coarse to 500-fine)
√ Instant change from one grit to another
√ Higher speeds, cooler cutting, better finish from
√ Greater abrading area (averages 3 to 1) and
√ Resilient Contact Wheel

. . . as contrasted with . . .

Difficulty of duplication—at best a massive surface
Wasteful, messy job of rolling loose abrasive into wet glue
Down time to make grit (wheel) changes
Time and space lost in preparation and storage
Hard, unyielding cutting face

•

You will be interested in our illustrated eight-page folder, "PLUS FACTORS" telling the advantages of Idler-Backstands in greater detail. It describes ease of change-over; shows pictures of actual installations, gives reports on increased output (up to 17 to 1) and the makes of machines on the market and convincing testimony to the benefits of this modern, easy, economical conversion method. Drop us a line on your letterhead.

QUALITY ABRASIVES

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(Division of Norton Company)
Reliable Coated Abrasives Since 1872

ive water paste on a cloth wheel. In this operation speed and pressure are critical factors. For ashing, a wheel surface speed of approximately 900 fpm. is needed. Speed and pressure must be held within close limits to prevent overheating, poor finish, and drag marks. The plastic and wheel should be kept in constant motion with relation to each other. Remove sanding or ashing scratches by buffing.

It is important that the surface be carefully washed between finishing operations to prevent transfer of coarse abrasive to buffing wheels. For buffing, surface speeds of 2,000 fpm. are recommended. If the buffing wheels have been used before, remove any hardened tallow by running them against a metal edge. Start the wheel and rub with a stick of tallow for a few seconds. Apply the edge of the revolving wheel lightly to the surface, keeping it moving over the plastic with light pressure. Excessive pressure may heat and soften the plastic. Buff both along and across any scratch. Continue buffing until all scratches have been removed, then wipe off buffing compound.

As a final operation, obtain a high polish by using a good paste or water-emulsion wax. Here, the wax should be applied by hand, with a soft cloth, in the same manner as polish. The polish not only protects the surface but will effectively fill tiny hair scratches and make them less apparent. Suitable waxes should have no chemical effect on the plastic and should contain no abrasive.

Repair of acrylic plastic sections is of course not as satisfactory as replacement of damaged areas. However, where facilities are not available for replacement, the following repair procedures may be utilized:

For emergency repair of holes and cracks, small holes should be drilled at the ends of each crack to relieve stress concentrations and prevent lengthening of the crack (see Fig. 3). In the case of long cracks, a series of small holes may be drilled along both sides. Then lace with wire. For more effective temporary repairs a patch of acrylic plastic can be cemented over the damaged area, which should be trimmed before patching. A piece of plastic should be cut to size and the edges beveled (Fig. 4).

If the section to be repaired is curved, the patch may be softened by heating, then shaped by pressing it over the area to which it is to be applied. If held in place until cool, a good fit is assured. Inner surface is then treated with cement and patch is pressed into position. Slight pressure should be applied to patch by use of weights or clamps. Another method of holding the patch in position is to place a bridge over the patch, the ends of the bridge being fixed to the solid outside plastic by suction cups. A screw in the center of the bridge applies light pressure to the patch.

Another effective temporary repair is the plug patch (Fig. 5). Cut a circular hole in panel and bevel edges as shown. A plug is cut and beveled to fit. If the panel is curved, the plug should be formed to the existing curvature.

In cleaning the exterior, flush with plenty of water, using the bare hand to feel and dislodge any dirt before it scratches the plastic surfaces. Wash the plastic with soap and water and be sure the water is free of possible abrasives. A soft cloth, sponge, or chamois may be used, but only as a means of applying the soapy water to the plastic. The actual washing of the plastic should be accomplished with the bare hand to prevent scratching of the surfaces.

It is preferable to dry the surface with a clean, damp chamois. However, a soft, clean, dry cloth may be used if care is taken not to continue rubbing the plastic after it is dry. Continuous rubbing is likely to cause scratches and also builds up a static charge which

ELLSTROM

CHROMIUM PLATED

ROUND GAGE BLOCKS

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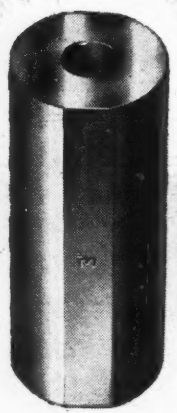

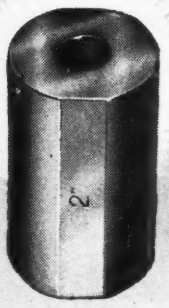

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AVAILABLE in three standard degrees of accuracy—"working sets" with a guaranteed tolerance of plus or minus, .000008 inch per inch of gage, "inspection sets" with a guaranteed tolerance of plus or minus .000004 inch per inch of gage and "laboratory sets" with a guaranteed tolerance of plus or minus .000002 inch per inch of gage.

1. When you use the new Ellstrom round gage blocks, practically *all* of the gaging surface can be utilized because there are no corners, as in the case of the rectangular or square blocks. For example, the gaging area of a round block is .9970 square inch while the gaging area of a rectangular block is .4968 square inch. Gage life is thereby increased.

2. Chromium plating increases gage life many times over ordinary steel gage blocks.

3. Use of the round shape gage virtually eliminates chances of tipping, causing possible injury to the gaging surface. "Flats" prevent rolling.

4. Gage quickly returns to room temperature after handling, because of center holes.

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PRICES PER SET

Set No. 2-85-W	$464.00
Set No. 2-85-I	695.00
Set No. 2-81-W	437.50
Set No. 2-81-I	656.25
Set No. 2-35-W	222.50
Set No. 2-35-I	318.75
Set No. 2-36-W	259.35
Set No. 2-36-I	373.75

(Prices on individual blocks on request)

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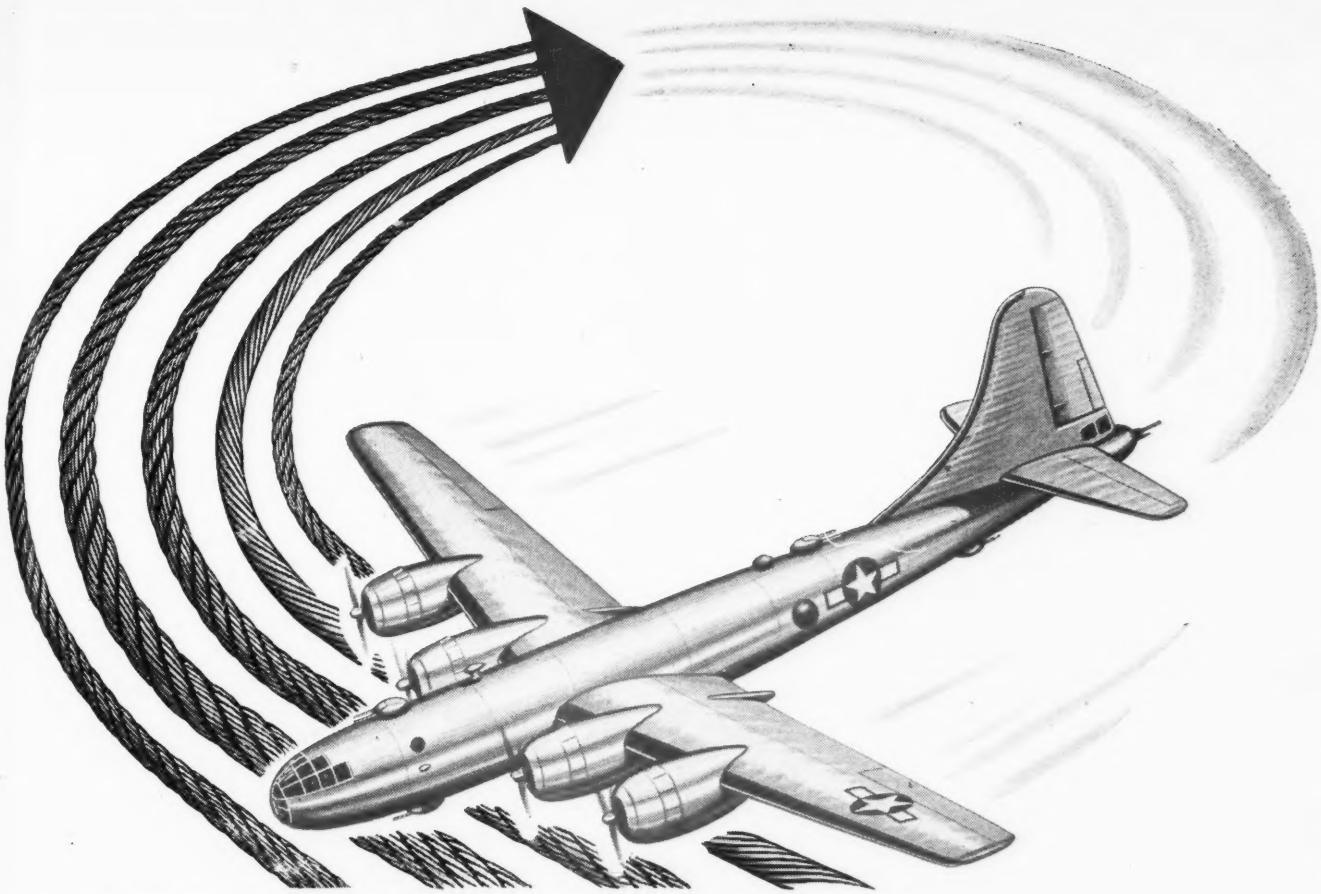

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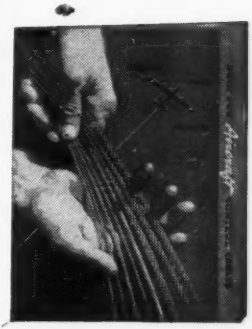

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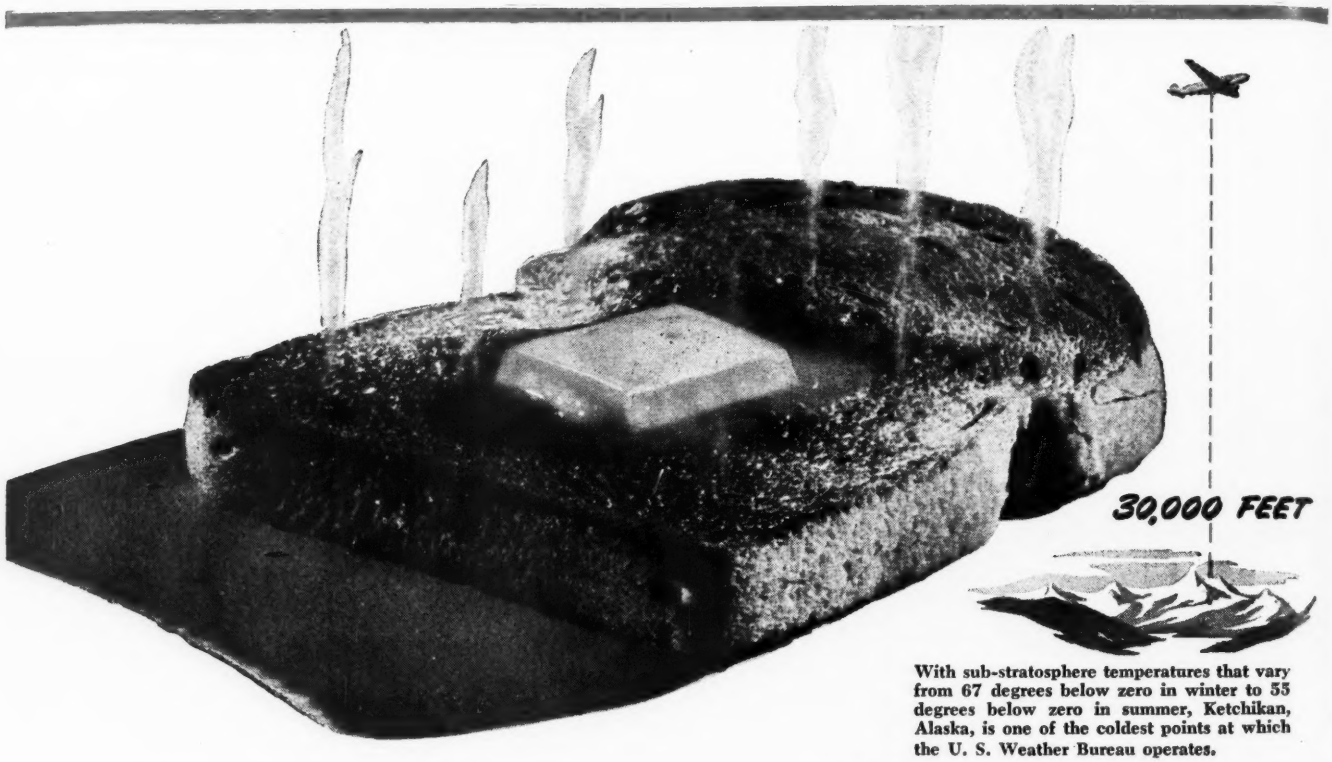


With sub-stratosphere temperatures that vary from 67 degrees below zero in winter to 55 degrees below zero in summer, Ketchikan, Alaska, is one of the coldest points at which the U. S. Weather Bureau operates.

...30,000 feet over Ketchikan!

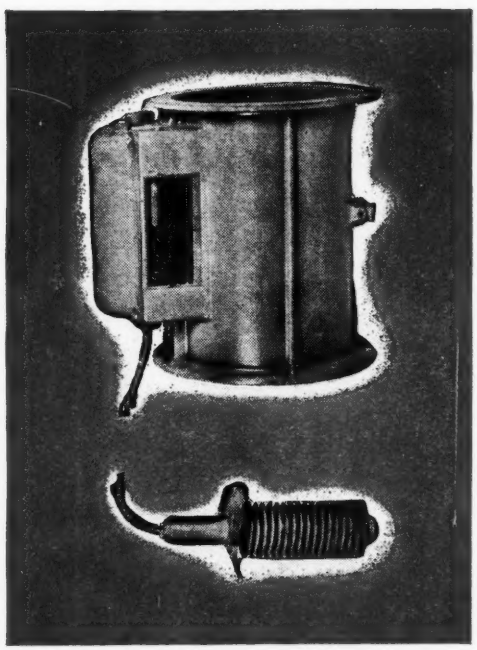
When it rises to 55 below at 30,000 feet, it's summertime in Ketchikan. Even there, living room comfort in planes flying the Arctic wastes is a relatively simple problem for No. 707 Fulton Sylphon Temperature Regulator.

Battle-tested in big bombers throughout the war, used under practically every condition of maintenance, this unit is one of many automatic devices now available to add to the comfort of world-wide air travel.

Like most Fulton Sylphon aircraft instruments, operation is very simple. Here is how it works:

Heated air is supplied through heat exchangers installed on exhaust lines of inboard engines. No. 707 insures complete temperature control, thermostatically governing the amount of cold fresh air admitted from external scoops.

Write for Bulletin XA-1300. It gives complete information about No. 707 and other Fulton Sylphon instruments which help add peace of mind and body to flyers. The Fulton Sylphon Co., Knoxville 4, Tennessee. Canadian Representatives, Darling Brothers, Montreal.



No. 707 Temperature Regulator proportions mixture of hot and cold air admitted to heater ducts to maintain constant temperature no matter how cold the outside air.

attracts dust particles to the surface. If the surface does become charged, patting or gently blotting with a clean, damp chamois will remove both this charge and the dust.

If oil or grease is on the surface, it can be removed by rubbing lightly with a cloth dampened with kerosene or hexane only. Do not use other cleaning fluids, since they will soften plastic and cause crazing. If, after removing dirt and grease, any scratching is visible, the surface should be waxed or buffed, as previously explained.

In general, because sunlight has little effect on plastics, covers need not be used unless there is danger of sand or dust being blown over the surfaces. When used, these covers should not be drawn tightly over the enclosure, since the pressure may cause distortion. Allow room for air circulation beneath the covers when parking under the direct rays of the sun. It is also recommended that doors and windows be opened slightly to permit free circulation of air through the cabin. This will assist in preventing a high internal temperature which might soften or distort the plastic panels.

Aircraft Plastics Servicing Materials

Buffing Compounds

Compound 771—Matchless Metal Polish Co., Glen Ridge, N. J.
Learock 765 and Learock 832—Lea Mfg. Co., Waterbury, Conn.
Compound 4M-30, Compound 6M-157, and Emery Wheel Lubricant M.T.—Hanson-Van Winkle-Munning Co., Matawan, N. J.
Triple A Buffing Compound and Buffing Tallow—McAleer Mfg. Co., P. O. Box 149, Rochester, Mich.
Plascor 1403 and Plascor 705—United Laboratories, Linden, N. J.
Pumice, grades FF and FFF—James H. Rhodes, Chicago, Ill.
Rubbing Compounds 12 (fine) and 45 (rough)—E. I. duPont de Nemours Co., Wilmington, Del.

Polishes

Aerogroom Cleaner—Autogroom Co., 68-02 38th Ave., P. O. Box 4, Woodside, L. I., N. Y.
Crystal X Cleaner and Glaze—Croasdale & de Angelis, Eagle and Lawrence Rds., Upper Darby, Pa.
Triple Life Cleaner and Glaze—Franklin Research Co., 5314 Lancaster Ave., Philadelphia, Pa.
Ken-Glo—Ken-nite Co., 2926 Hancock Ave. W., Detroit, Mich.
Lincoln M-3828 Liquid Cleaner—Lincoln Motor Car Div., Ford Motor Co., Dearborn, Mich.
Plex-I-Glo Cleaner and Polish—McAleer Mfg. Co., P. O. Box 149, Rochester, Mich.
Noxon Cleaner Polish—Noxon, Inc., 94-02 104th St., Ozone Park, N. Y.
O'Cedar M37 Plastic Polish—O'Cedar of Canada, 365 Sorauren Ave., Toronto 3, Ontario, Can.
Parko Gloss Polish and Cleaner 4B-L—Park Chemical Co., Military and Vancouver Aves., Detroit, Mich.
Phenoid Cleaner No-White 984 and Phenoid Cleaner Regular 981—Chalmers Chemical Co., 123 Chestnut St., Newark, N. J.
Plasti-Kleen—Puritan Chemical Co., Atlanta, Ga.
Simoniz Liquid Kleener—Simoniz Co., 2100 Indiana Ave., Chicago, Ill.
Turco L-567 Cleaner—Turco Products, P. O. Box 2649, Terminal Annex, Los Angeles, Calif.
Wilco Scratch Removing Compounds 35 and 55—Wilco, 6800 McKinley Ave., Los Angeles, Calif.
No. 7 Polish—E. I. duPont de Nemours Co., Fabrics and Finishes Dept., Wilmington, Del.

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This is a junction box of the Lockheed Lightning P-38. Crowded, isn't it? In it are the vital and complicated power and control circuits of a single engine of the famous fighter.

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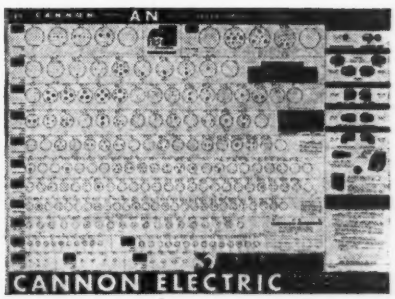
Write for this AN Wall Chart. It identifies at a glance the right Cannon Plug (insert arrangement and shell size) for the job you're working on. Address Dept. A-110, Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif. ***...The plug shown at right, above, is representative of the famous Cannon AN line.***



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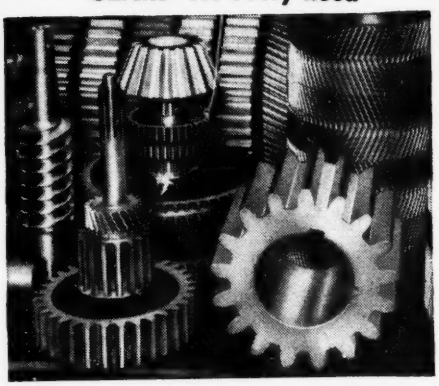

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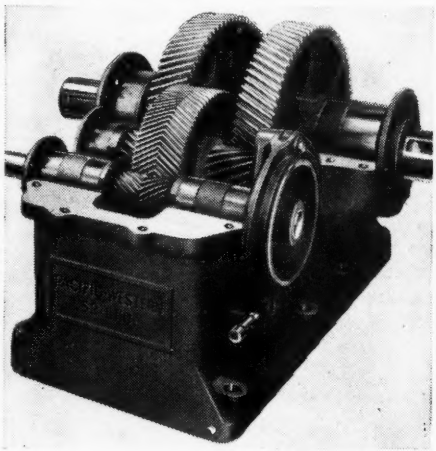

Pacific-Western Speed Reducers are available for ratios of 2:1 to 300:1; for transmitting from fractional horsepower to 1,500 hp., in standard units. Larger special units available upon request. Full range of sizes are available in single, double and triple reductions with single or multiple power takeoffs.

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Duco 7 Wax—E. I. duPont de Nemours Co., Wilmington, Del.
Plexiglas Wax and Triple Life Wax and Paint Protector—Franklin Research Co., 5134 Lancaster Ave., Philadelphia, Pa.
Industrial Wax 102-C—S. C. Johnson & Son, Industrial Wax Div., Racine, Wis.
Parko Eze-Wax — Park Chemical Co., Military and Vancouver Aves., Detroit, Mich.
Permaseal—Commercial Chemical Co., 235 Medford St., Charlestown, Boston, Mass.
Simoniz Wax—Simoniz Co., 2100 Indiana Ave., Chicago, Ill.
3M Auto Wax—Minnesota Mining & Mfg. Co., St. Paul, Minn.

Bombing Record

(*Continued from page* 107)

the tonnage dropped on city areas, plus spill-overs from attacks on transportation and other specific targets, mounted greatly. In the course of these raids, Germany's steel industry was knocked out, its electric power industry was substantially impaired, and industry generally in the areas attacked was disorganized. There were so many forces making for collapse of production during this period, however, that it is not possible separately to assess the effect of these later area raids on war production. There is no doubt, however, that they were significant.

The Survey has made extensive studies of the reaction of the German people to the air attack and especially to city raids. These studies were carefully designed to cover a complete cross section of the people in western and southern Germany and to reflect with a minimum of bias their attitude and behavior during the raids. These studies show that morale of the German people deteriorated under aerial attack. Night raids were feared far more than daylight raids. The people lost faith in the prospect of victory, in their leaders, and in the promises and propaganda to which they were subjected. Most of all, they wanted the war to end. They resorted increasingly to "black radio" listening, to circulation of both rumor and fact in opposition to the Regime; and there was some increase in active political dissidence —in 1944 one German in every thousand was arrested for a political offense.

The city area raids have left their mark on the German people as well as on their cities. Far more than any other military action that preceded the actual occupation of Germany itself, these attacks left the German people with a solid lesson in the disadvantages of war. It was a terrible lesson; conceivably that lesson, both in Germany and abroad, could be the most lasting single effect of the air war.

The USAAF entered the European

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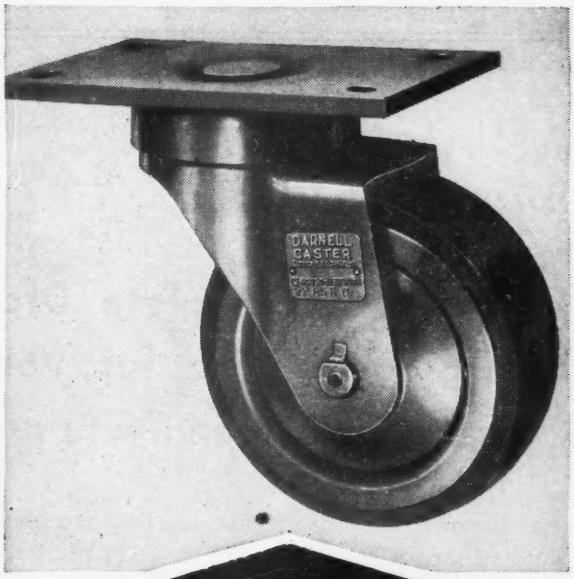

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We have produced forgings weighing up to 25 pounds and more, and as small as one ounce in weight.

And, in addition to our forge development, Aircraft Mechanics, Inc., has produced many thousands of welded tubular and machined parts for more than 50 major manufacturers participating in the war production program. A portion of these facilities also are now available to manufacturers.

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war with the firm view that specific industries and services were the most promising targets in the enemy economy, believing that if these targets were to be hit accurately, attacks had to be made in daylight. A word needs to be said on the problem of accuracy in attack. Before the war, the AAF had advanced bombing techniques to their highest level of development and had trained a limited number of crews to a high degree of precision in bombing under target range conditions, thus leading to the expressions "pin point" and "pickle barrel" bombing.

However, it was not possible to approach such standards of accuracy under battle conditions imposed over Europe. Many limiting factors intervened; target obscuration by clouds, fog, smoke screens, and industrial haze; enemy fighter opposition which necessitated defensive bombing formations, thus restricting freedom of maneuver; anti-aircraft defenses, demanding minimum time exposure of the attacking force to keep losses down; and finally, time limitations imposed on combat crew training after the war began.

The air forces designated as "the target area" a circle having a radius of 1,000 ft. around the aiming point of attack. While accuracy improved during the war, Survey studies show that only about 20 percent of the bombs aimed at precision targets fell within this target area. A peak accuracy of 70 percent was reached for the month of Feb., 1945. These are important facts to keep in mind, especially when considering the tonnages of bombs delivered. Of necessity a far larger tonnage was carried than hit German installations.

Although the 8th Air Force began operations Aug. 17, 1942, bombing marshalling yards at Rouen and Sotteville, no operations during 1942 or the first half of 1943 had significant effect. The force was small and its range limited. Much time in this period was devoted to training and testing the force under combat conditions.

In Nov., and Dec., 1942, the U-boat attack on Allied shipping was in its most successful phase, hence submarine bases and pens and later construction yards became the chief target and remained so until June 1943. These attacks accomplished little. The submarine pens were well protected: bombs did not penetrate the 12-ft. concrete roofs. The attack on the construction yards and slipways was not heavy enough to be more than troublesome.

At Casablanca the objective of the strategic air forces was established as the "destruction and dislocation of the German military, industrial, and eco-

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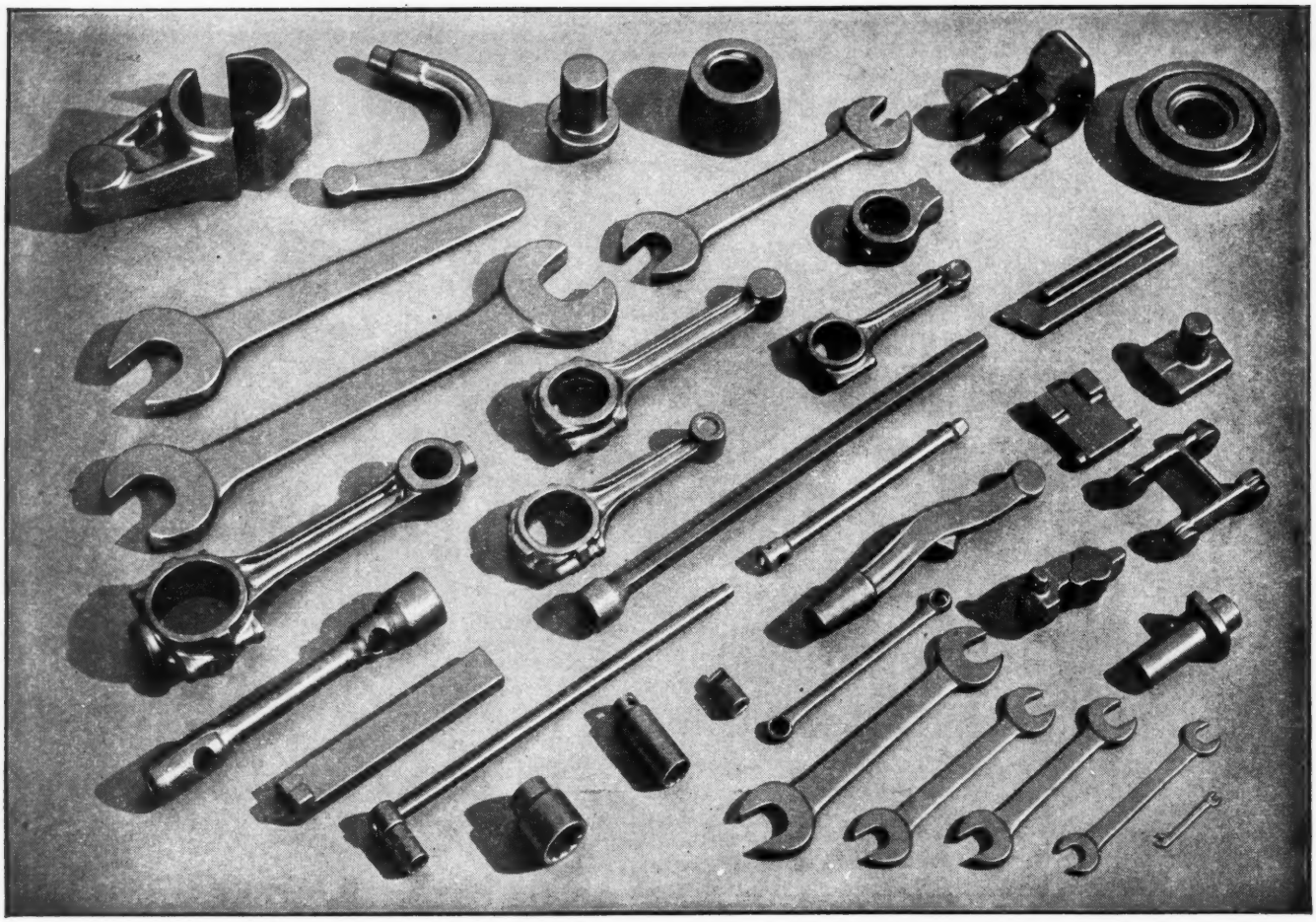

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nomic system and the undermining of the morale of the German people to the point where their capacity for armed resistance is fatally weakened." Specific target systems were named.

In the spring of 1943, Allied naval and airpower scored a definite victory over German submarines. Surface craft, teamed with long-range radar-equipped patrol bombers, raised German submarine losses to catastrophic levels. Interrogation of the German Navy High Command, including Adm. Doenitz, has confirmed the scope of this victory. When the Combined Bomber Offensive Plan was issued in June, 1943, to implement the Casablanca directive, submarines were dropped from first priority and the German aircraft industry was substituted. The ball-bearing industry, the supplier of an important component, was selected as a complementary target.

The German anti-friction bearing industry was heavily concentrated. When the attack began, approximately half the output came from plants in the vicinity of Schweinfurt. An adequate supply of bearings was correctly assumed to be indispensable for German war production.

In a series of raids beginning Aug. 17, 1943, about 12,000 tons of bombs were dropped on this target—about 0.5 percent of the total tonnage delivered in the air war. In an attack Aug. 17 by 200 Boeing B-17s on Schweinfurt, the plants were severely damaged. Records of the industry taken by the Survey (and supplemented and checked by interrogation) show that production of bearings at this center was reduced sharply—September production was only 35% of the pre-raid level.

In this attack 36 of the 200 attacking planes were lost. In the famous and much-discussed second attack on Oct. 14, 1943, when the plants were again severely damaged, one of the decisive air battles of the war took place. The 228 bombers participating were strongly attacked by German fighters when beyond the range of their fighter escort. Losses to fighters and to flak cost the United States forces 62 planes with another 138 damaged in varying degree, some beyond repair. Repeated losses of this magnitude could not be sustained; deep penetrations without escort, of which this was among the earliest, were suspended, and attacks on Schweinfurt were not renewed for four months.

The Germans made good use of the breathing spell. A czar was appointed with unlimited priority for requisitioning men and materials. Energetic steps were taken to disperse the industry. Restoration was aided by the circumstance—which Survey investigations show to have been fairly common to

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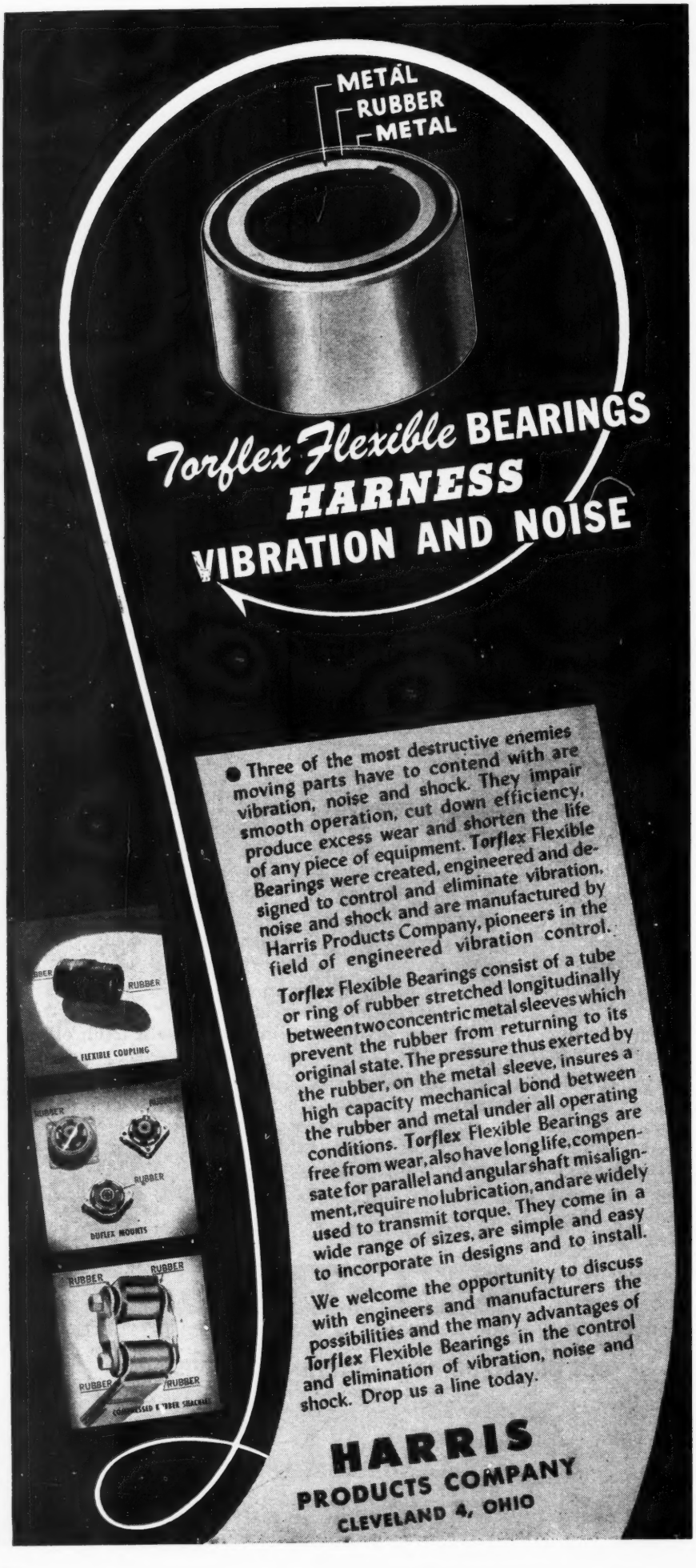
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all such raids—that machines and machine tools were damaged far less severely than factory structures. German equipment was redesigned to substitute other types of bearings wherever possible. And the Germans drew on the substantial stocks that were on hand.

Although there were further attacks, production by autumn of 1944 was back to pre-raid levels. From examination of both the records and personalities in the ball-bearing industry, plus the user industries, and the testimony of war production officials, there is no evidence that attacks on the ball-bearing industry had any measurable effect on essential war production.

Heavy losses over Schweinfurt caused an important revision in the tactics of daylight bombing. Until then it had been believed that unescorted bombers, heavily gunned and flying in well designed formations, could penetrate this deeply over the Reich. At least, so far as a small force was concerned, this was proven wrong. For the remainder of 1943 daylight penetrations beyond fighter escort were sharply circumscribed. Meanwhile the U. S. heavy bomber force increased substantially in strength.

In Dec., 1943, the North American P-51 Mustang long range fighter first became available and in the early months of 1944 the numbers increased. With this plane, in some respects the most important addition to Allied air power during the European war, augmenting the Republic P-47 Thunderbolt escorts which in the meantime had materially increased their range, daylight operations in depth were again launched.

The attack on the German aircraft industry—primarily on airframe plants—was opened in the summer of 1943. The German aircraft industry had been well distributed over the Reich with a view to the possibility of air attack. Isolated raids early in 1941 and 1942 had caused some further shift in production to eastern territory, but only limited steps had been taken to disperse individual plant units to reduce their vulnerability. The industry was found to have had substantial excess capacity. The efficiency of the industry was low. Unlike other armaments, procurement was not under the direction of the Speer Ministry, but under the Luftwaffe.

Production early in the war was small, primarily because Luftwaffe requirements were modest—in 1941 according to captured minutes of German staff conferences, Gen. Jeschonneck, then chief of the air staff, opposed a suggested increase in fighter plane production with the remark that he wouldn't know what to do with a

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monthly production of more than 360 fighters. However, in the autumn of 1943 plans then current called for a steadily increasing output of fighters.

In the 1943 attacks, 50,092 tons were dropped on 14 plants, primarily airframe plants. Records show that acceptances of the Me-109 dropped from 725 in July to 536 in September and to a low of 357 in December. Acceptances of Focke-Wulf 190s dropped from 325 in July to 203 in December. As a result of the attacks the Germans began a more vigorous program of subdividing and dispersing aircraft plants, and this caused part of the reduction in production. A further but undetermined part was the result of poor weather which cut down acceptance flights; it is probable that some planes produced but not accepted during these months were added to acceptance figures in the months following. As a result of these attacks, the Nazis decided to place increased emphasis on production of fighter planes.

The culminating attacks on the German aircraft industry began in the last week of Feb. 1944. With the protection of long-range fighter escort, 3,636 tons of bombs were dropped on aircraft plants (again, airframe rather than engine plants) during that week. In that and succeeding weeks every known aircraft plant in Germany was hit.

Detailed production data for this period, as for others, were taken by the Survey, and German air generals, production officials, and leading manufacturers, including Messerschmitt and Tank (of Focke-Wulf) were interrogated at length. On the contrary, during the whole year of 1944 the German air force is reported to have accepted a total of 39,807 aircraft of all types—compared with 8,295 in 1939, or 15,596 in 1942 before the plants suffered any attack. Although it is difficult to determine exact production for any single month, acceptances were higher in March (the month after the heaviest attack) than they were in January (the month before). They continued to rise.

Part of the explanation was the excess capacity of the airframe industry which, as noted, was considerable. Excess capacity in airframes was considerably greater than in engines. Studies of individual plants by the Survey show that although buildings were destroyed the machine tools showed remarkable durability. And the Germans showed capacity for improvising their way out.

Immediately after the attacks, responsibility for production was shifted from the Luftwaffe to the Speer Ministry. A special staff was organized

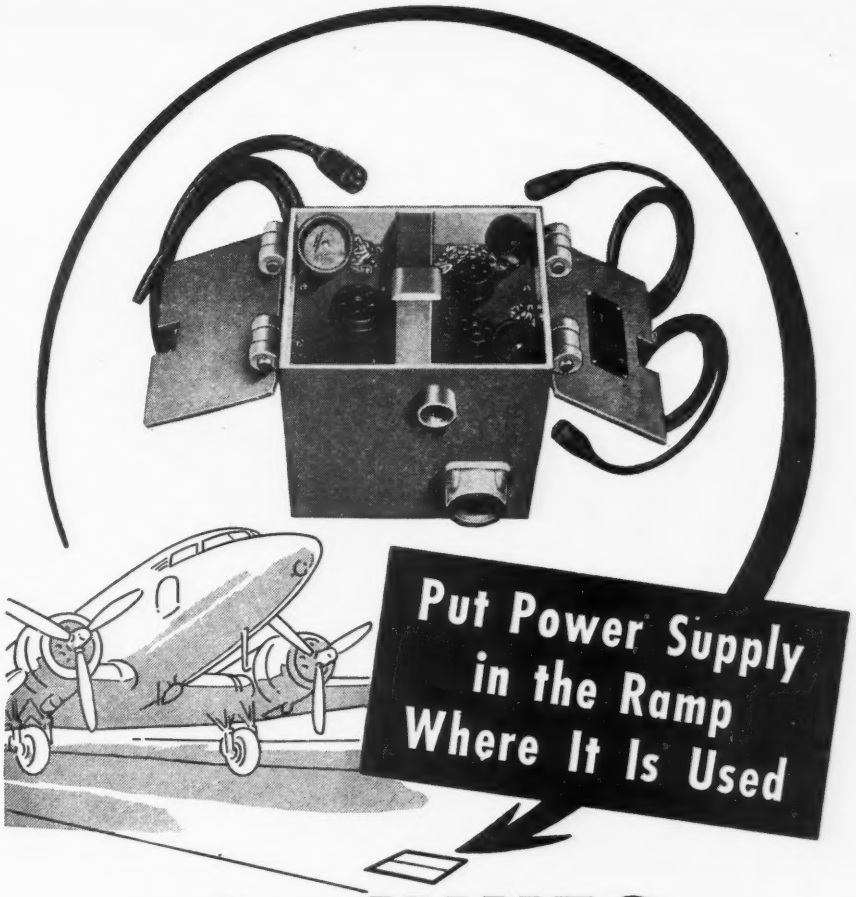
for the reconstitution and dispersal of the industry. This staff (the *Jaegerstab* or Fighter-Staff) appears to have done an effective job of mobilizing unused capacity and undamaged machines, reorganizing inefficient managements, reducing the number of types of planes and, most important of all, in subdividing production into small units that were comparatively immune from attack. This Staff was aided by previous plans for expansion and it cut sharply into available inventories of parts. Although the testimony on the point is conflicting, the Jaegerstab may have sacrificed quality and an adequate complement of spare parts, for quantity production.

Nevertheless the attack on aircraft plants, like the attack on the ball-bearing plants, showed that to knock out a single industry with the weapons available in 1943 and early 1944 was a formidable enterprise demanding continuous attacks to effect complete results. Recovery was improvised almost as quickly as the plants were knocked out. With the shift in priority for strategic attacks—first to marshalling yards and bridges in France in preparation for invasion, immediately followed by the air campaign against oil—the continued attacks on the aircraft indstry were suspended.

After September, German aircraft production declined gradually until December, when 3,155 planes were accepted. And in Jan. 1945, because of the shortage of gasoline, production of all except jet types was virtually discontinued. The jet planes, especially the Me-262, (see page 115 Oct. and page 115 Nov. AVIATION) were the most modern planes which any belligerent had in general operation at the end of the war. According to manufacturers and other competent observers, their production was delayed because of failure of the Luftwaffe to recognize in time the advantages of the type.

It was also delayed because Hitler intervened in 1944 with an ill-timed order to convert the Me-262 to a fighter-bomber. Virtually every manufacturer, production official, and air force general interrogated, including Goering himself, claimed to have been appalled by this order. By May 1945, 1,400 jets had been produced. Had these planes been available six months earlier with good quality pilots, though they might not have altered the course of the war, they would have sharply increased the losses of the attacking forces.

Allied airpower was decisive in the war in Western Europe. Hindsight inevitably suggests it might have been employed differently or better in some respects. Nevertheless, it was decisive.



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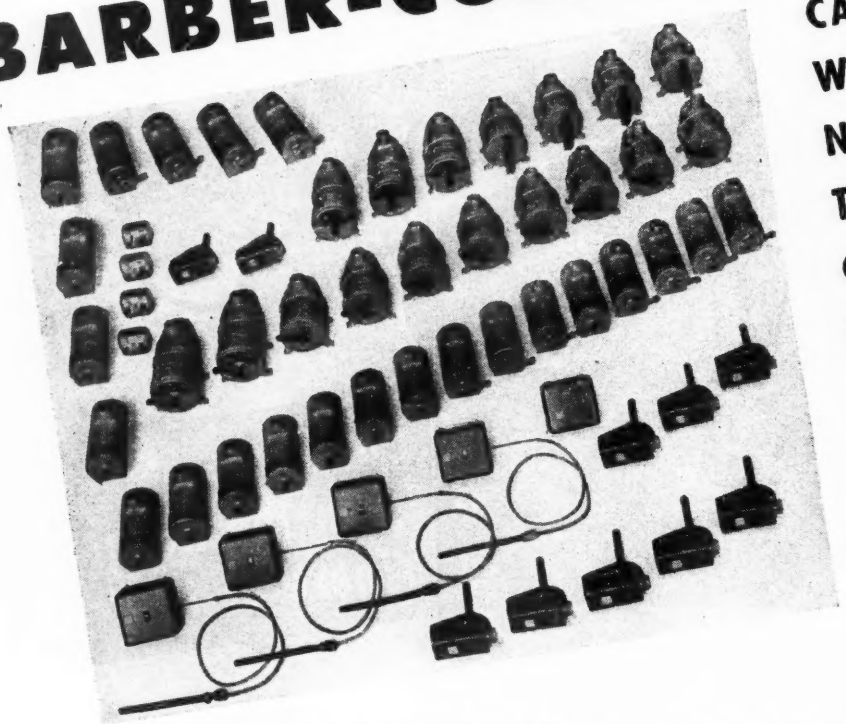

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TURBO SUPERCHARGERS
CABIN PRESSURE
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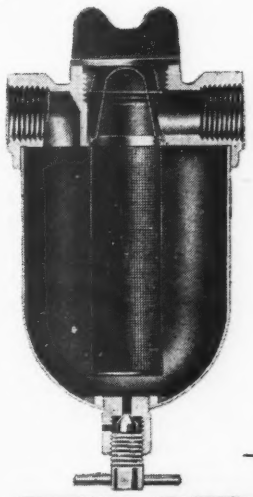
It brought the economy which sustained the enemy's armed forces to virtual collapse, although the full effects of this collapse had not reached the enemy's front lines when they were overrun by Allied forces. It brought home to the German people the full impact of modern war with all its horror and suffering. Its imprint on the German nation will be lasting. Accordingly—

1. The German experience suggests that even a first class military power—rugged and resilient as Germany was—cannot live long under full-scale and free exploitation of air weapons over the heart of its territory. By the beginning of 1945, before the invasion of the homeland itself, Germany was reaching a state of helplessness. Her armament production was falling irretrievably, orderliness in effort was disappearing, and total disruption and disintegration were well along. Her armies were still in the field. But with the impending collapse of the supporting economy, indications are convincing that they would have had to cease fighting—any effective fighting—within a few months. Germany was mortally wounded.

2. The significance of full domination of the air over the enemy—both over its armed forces and over its sustaining economy—must be emphasized. That domination of the air was essential. Without it, attacks on the basic economy of the enemy could not have been delivered in sufficient force and with sufficient freedom to bring effective and lasting results.

3. As the air offensive gained in tempo, the Germans were unable to prevent the decline and eventual collapse of their economy. Nevertheless, the recuperative and defensive powers of Germany were immense; the speed and ingenuity with which they rebuilt and maintained essential war industries in operation clearly surpassed Allied expectations. Germany resorted to almost every means an ingenious people could devise to avoid the attacks upon her economy and to minimize their effects. Camouflage, smoke screens, shadow plants, dispersal, underground factories, were all employed. In some measure all were helpful, but without control of the air, none was really effective. Dispersal brought a measure of immediate relief, but eventually served only to add to the many problems



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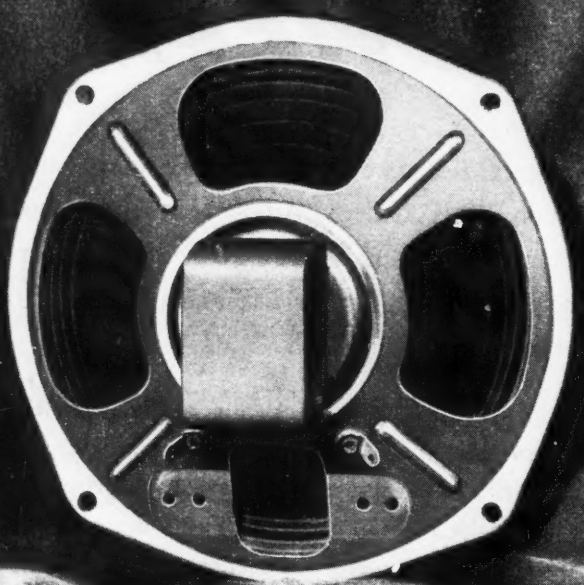

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caused by attacks on the transportation system. Underground installations prevented direct damage, but they, too, were often victims of disrupted transportation and other services. In any case, Germany never succeeded in placing any substantial portion of her war production underground—the effort was largely limited to certain types of aircraft, their components, and the V weapons. The practicability of going underground as the escape from full and free exploitation of the air is highly questionable; it was so considered by the Germans themselves. Such passive defenses may be worthwhile and important, but it may be doubted if there is any escape from air domination by an enemy.

4. The mental reaction of the German people to air attack is significant. Under ruthless Nazi control the populace showed surprising resistance to the terror and hardships of repeated air attack, to the destruction of their homes and belongings, and to the conditions under which they were reduced to live. Their morale, their belief in ultimate victory or satisfactory compromise, and their confidence in their leaders declined, but they continued to work efficiently as long as the physical means of production remained. The power of a police state over its people cannot be underestimated.

5. The importance of careful selection of targets for air attack is emphasized by the German experience. The Germans were far more concerned over attacks on one or more of their basic industries and services—their oil, chemical, or steel industries, or their power or transportation networks—than they were over attacks on their armament industry or the city areas. The most serious attacks were those which destroyed the industry or service which most indispensably served other industries. The Germans found it clearly more important to devise measures for the protection of basic industries and services than for the protection of factories turning out finished products.

6. The German experience showed that, whatever the target system, no indispensable industry was permanently put out of commission by a single attack. Persistent re-attack was necessary.

7. In the field of strategic intelligence, there was an important need for further and more accurate information, especially before and during the early phases of the war. The information on the German economy available to the AAF at the outset of the war was inadequate. And there was no established machinery for coordination between military and other governmental and private organizations. Such ma-

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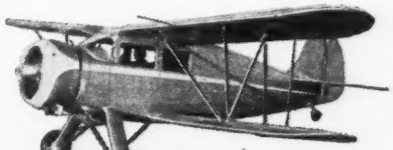

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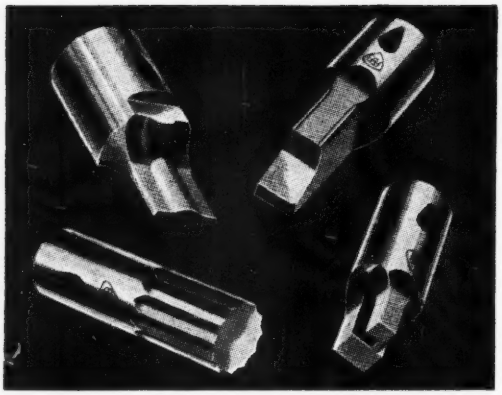

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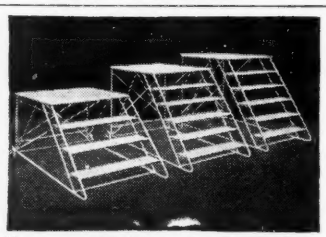

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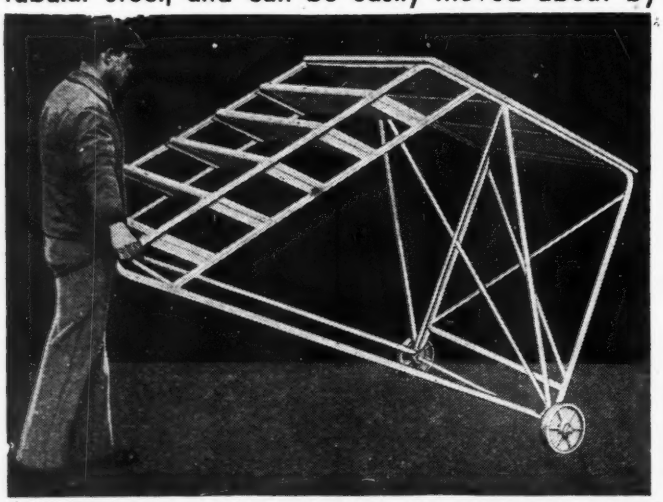

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chinery was developed during the war. The experience suggests the wisdom of establishing such arrangements on a continuing basis.

8. Among the most significant of the other factors which contributed to the success of the air effort was the extraordinary progress during the war of Allied research, development, and production. As a result of this progress, the air forces eventually brought to the attack superiority in numbers and quality of crews, aircraft, and equipment. Constant and unending effort was required, however, to overcome initial advantages of the enemy and later to keep pace with his research and technology. It was fortunate for the Allies that the leaders of the German Air Force relied too heavily on their initial advantage. For this reason the Germans failed to develop, in time, weapons, such as their jet-propelled planes, that might have substantially improved their position. There was hazard, on the other hand, in the fact that the Allies were behind the Germans in the development of jet-propelled aircraft. The German development of the V weapons, especially the V-2, is also noteworthy.

9. Achievements of Allied airpower were attained only with difficulty and great cost in men, material, and effort. Its success depended on the courage, fortitude, and gallant action of the officers and men of the air crews and commands. It depended also on a superiority in leadership, ability, and basic strength. These led to a timely and careful training of pilots and crews in volume; to the production of planes, weapons, and supplies in great numbers and of high quality; to the securing of adequate bases and supply routes; to speed and ingenuity in development; and to cooperation with strong and faithful Allies. The failure of any one of these might have seriously narrowed and even eliminated the margin.

The air war in Europe was marked by continuous development and evolution. This process did not stop on VE-day; great strides have been made since in machines, weapons, and techniques. No greater or more dangerous mistake could be made than to assume that the same policies and practices that won the war in Europe will be sufficient to win the next one—if there should be another. The results achieved in Europe will not give the answer to future problems; they should be treated rather as signposts pointing the direction in which such answers may be found.

The great lesson to be learned in the battered towns of England and ruined cities of Germany is that the best way to win a war is to prevent it. That must be the ultimate end to which our best efforts are devoted. It has

been suggested—and wisely so—that this objective is well served by insuring the strength and security of the United States, which was founded, and has since lived upon, the principles of tolerance, freedom, and goodwill at home and abroad. Strength based on these principles is no threat to world peace. Prevention of war will not come from neglect of strength or lack of foresight or alertness on our part. Those who contemplate evil and aggression find encouragement in such neglect. Hitler relied heavily upon it.

Suggestions for assuring the strength and security of the United States are by no means intended as a recommendation for a race in arms with other nations. Nor do they reflect a lack of confidence in the prospect of international relationships founded upon mutual respect and goodwill which will themselves be a guarantee against future wars. The development of an intelligent and coordinated approach to American security can and should take place within the framework of the security organization of the United Nations.

Firebrand and Lincoln

(*Continued from page* 188)

means of crank handles operating on shafts extending from each latch-pin gearbox into wheel wells. Each handle has a clutch adjusted to slip at loads of 60-65 lb., the maximum effort required to insert or withdraw the pins. Handles are stored in wheel wells.

Gross weight of the Firebrand, fully loaded, is given as 15,671 lb., and maximum speed is stated to be 320 mph. at sea level and 342 mph. at 13,000 ft. Rate of climb is 2,200 fpm., while cruising speed (at 75% power at 10,000 ft.) is 256 mph., and stalling speed 75 mph. Span is 51 ft. 3½ in., length 39 ft. 1 in., and dihedral 5 deg.

In production in Britain, Canada, and Australia on V-J Day, the new Lincoln heavy bomber was specifically designed for the long ranges necessary in Pacific operations. Mark I version has four R-R Merlin 85 engines turning four-blade Rotol propellers, and the Mark 11 has Merlin 68s which turn deHavilland props. The aircraft's dimensions are given as 120 ft. span, 78 ft. 3½ in. length, 17 ft. 3½ in. height, and 1,421 sq. ft. wing area. Top speed is estimated as about 320 mph.

An interesting feature of this craft is the increased armament fitted, which may indicate a British trend away from use of the .303-cal. machine gun on bombers. The Lincoln has seven .50-cal. guns; two each in nose (remote control), in dorsal turret, and in tail turret, and one in a ventral turret.

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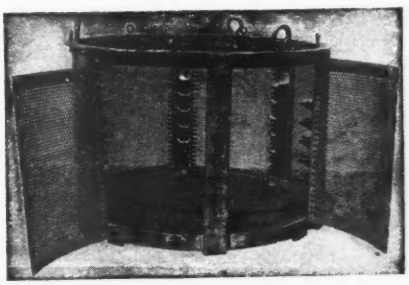

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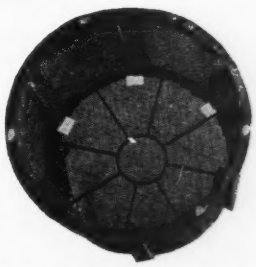

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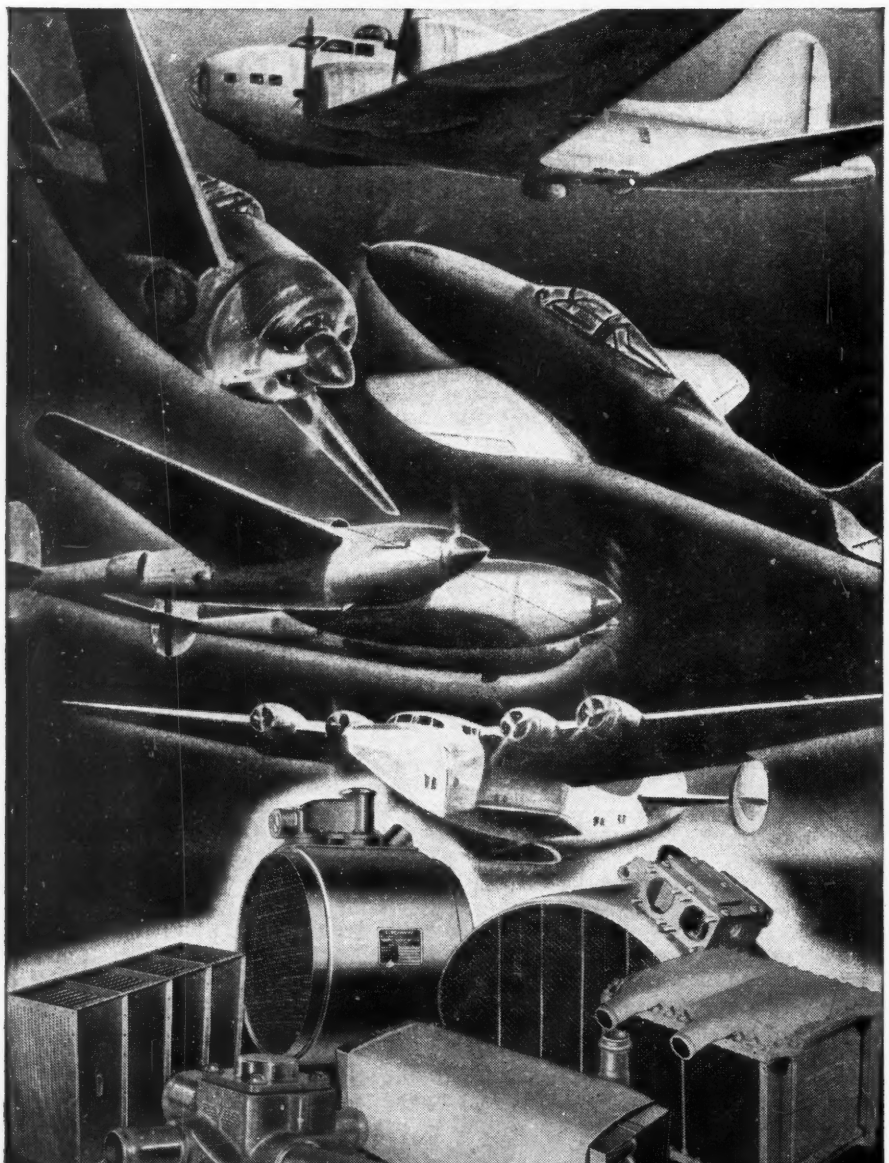

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Reviews of Patents

(*Continued from page* 213)

normal operating position to accessible position for servicing. Louver covering aperture in wing or fuselage is displaceable by gun.—2,385,024, filed Mar. 18, '43, pat. Sept. 18, '45, S. J. Palfrey, assignor to Blackburn Aircraft, Ltd.

Variable Pitch Propeller, embodying cushioning means for overcoming shocks and vibration occurring when air is choppy or during maneuvers, has pressure face of blade equipped with yieldable sheathing movable to and from blade at trailing edge, also rod which is slidable along length of blade to cause adjustment of sheathing for changing pitch.—2,385,028, filed Feb. 7, '42, pat. Sept. 18, '45, L. E. Reid.

Pilot Trainer provides novel screen on which images may be projected and viewed by student with same effect as in actual flight conditions, views being produced and moved according to movements of controls.—2,385,095, filed Apr. 30, '43, pat. Sept. 18, '45, C. C. McCarthy.

Engine Supercharger for aircraft embodies multiple stage exhaust turbine and two screw compressors arranged in parallel with respect to airflow. Part of energy of gases supplied to turbine and not utilized to drive supercharger are employed to produce rocket effect for propelling craft.—2,385,366, filed Apr. 18, '39, pat. Sept. 25, '45, A. Lysholm, assignor (by mesne assignments) to J. C. Marble, L. M. Merrill, and P. H. Batten.

Frost-Preventing Screen for inner face of aircraft windows comprises transparent inert material sheet mounted adjacent to pane and transparent active material layer exposed to atmosphere inside cabin. Latter layer is adapted at high-altitude low-temperature flight to absorb and retain, in unfrozen condition, substantial quantities of water from relatively humid atmosphere. Discharge of water, upon exposure to relatively higher temperatures and dry atmosphere, reconditions screen for another flight.—2,385,411, filed July 20, '43, pat. Sept. 25, '45, W. C. Geer.

Auxiliary Autogiro Means for aircraft employs rotor hub rotative in horizontal plane, plurality of blades pivotally mounted on hub, and cylinder-and-piston arrangement in hub to force blades into positions extending radially from hub or to cause blades to recede into parallel trailing positions.—2,385,464, filed Mar. 20, '41, pat. Sept. 25, '45, A. C. Peterson.

Pressure-Cabin Hatch, designed to be detachable, operates on tracks extending longitudinally of hatch, plurality of hooks being ingaged with tracks to clamp latter stationary. Control means, connected to hooks, effect unhooking and release of hatch and track unit as desired.—2,385,493, filed Aug. 13, '42, pat. Sept. 25, '45, H. L. Bowers, assignor to Bell Aircraft Corp.

Landing Stabilizer for Aircraft, intended to permit safe landing in short distance, employs pilot-operated shiftable counterweights on tracks for changing center of gravity rearwardly during landing operation, so that craft is rendered tail-heavy to prevent nosing over.—2,385,850, filed Apr. 10, 42, pat. Oct. 2, '45, J. Spiegel.

De-Icing Liquid Feeding Means to airfoil surfaces consists of channel elements designed to offer little resistance to flow in longitudinal direction but great resistance in lateral direction. Element is designed for uniform flow characteristics throughout its length so that amount of liquid distributed per unit of channel length is approximately uniform.—2,386,125, filed Nov. 2, '42, pat. Oct. 2, '45, C. C. S. Le Clair.

Improvement in Propeller aims to reduce noise and permit greatly increased speeds without causing fatigue in blade tip portion. Latter is provided with pitch which is reverse to pitch on remaining portion of blade, and featured are main (inner) driving zone, neutral intermediate zone, and outer (rearward) driving zone of such width as to counterbalance thrust of main zone and effect substantial floating of propeller.—2,386,154, filed Nov. 6, '42, pat. Oct. 2, '45, M. Weber.